Electroweak Physics and Searches for New Phenomena at CDF

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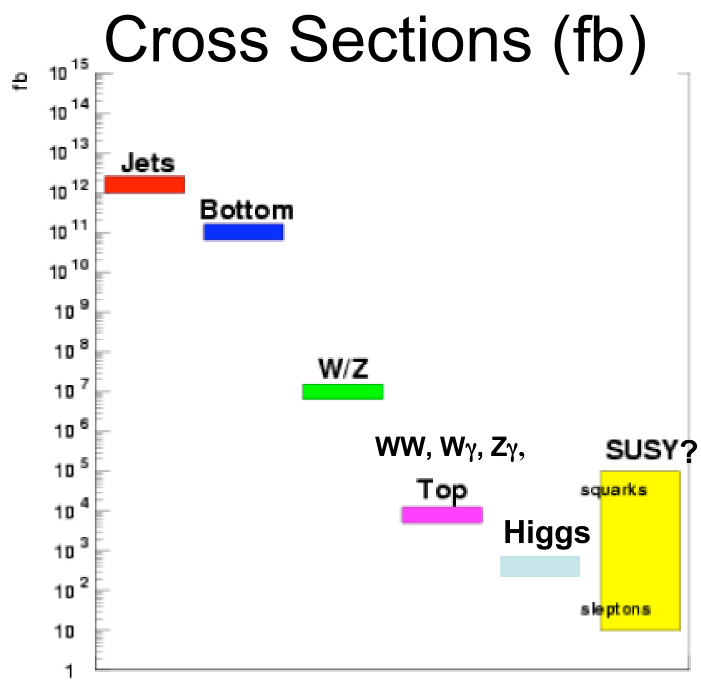
- The Tevatron and CDF
- Electroweak Physics
  - W,Z,Wγ, Zγ, WW Cross Sections
  - W and Top mass
- Searches:
  - Higgs
  - Supersymmetry
  - Z' and Extra Dimensions
- Summary and Outlook

Searches for New Physics: Strategy

1. Establish good understanding of data in EWK/QCD physics in Run 2:
   - Backgrounds to new physics searches
   - Indirect sensitivity to New Physics
   - Gain understanding of detector
2. Search for as many signatures as possible, involving:
   - High Pt leptons
   - Large imbalance in transverse momentum (e.g. due to neutrino or neutralino)
   - High Et jets
   - High Et photons
   - Rare decays of charm- and bottom-mesons
3. Interpret:
   - Provide cross section limits and acceptances (try to be as generic/model-independent as possible)➔ applicable to future models!
   - In context of specific models of physics beyond the SM

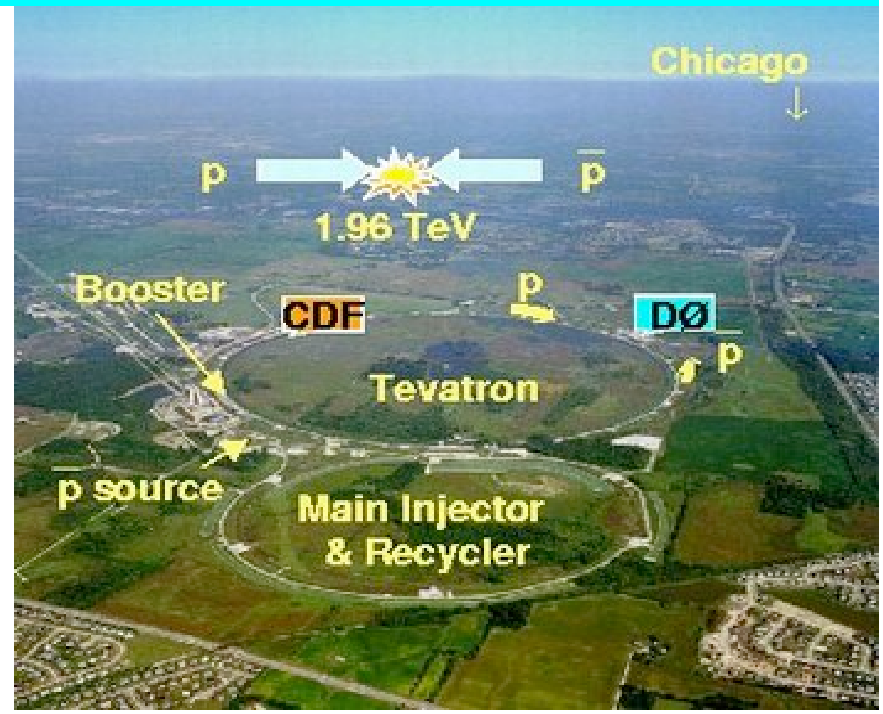


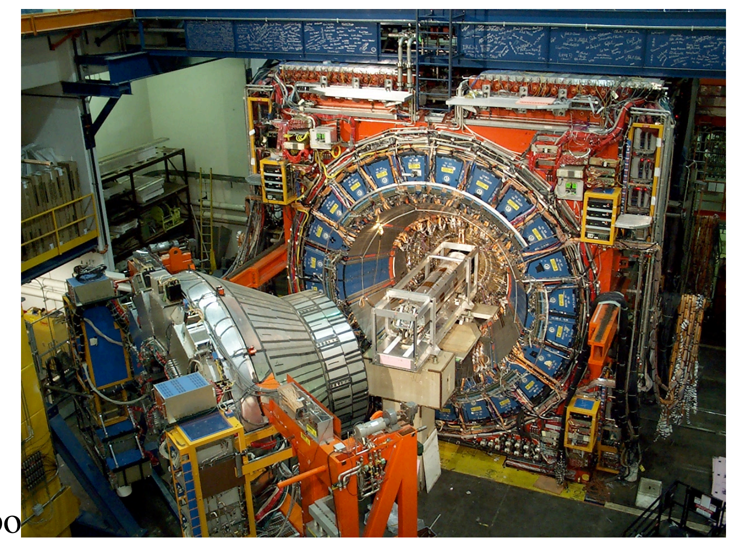
Tevatron Run II

- Upgrade completed in 2001
- Accelerator:

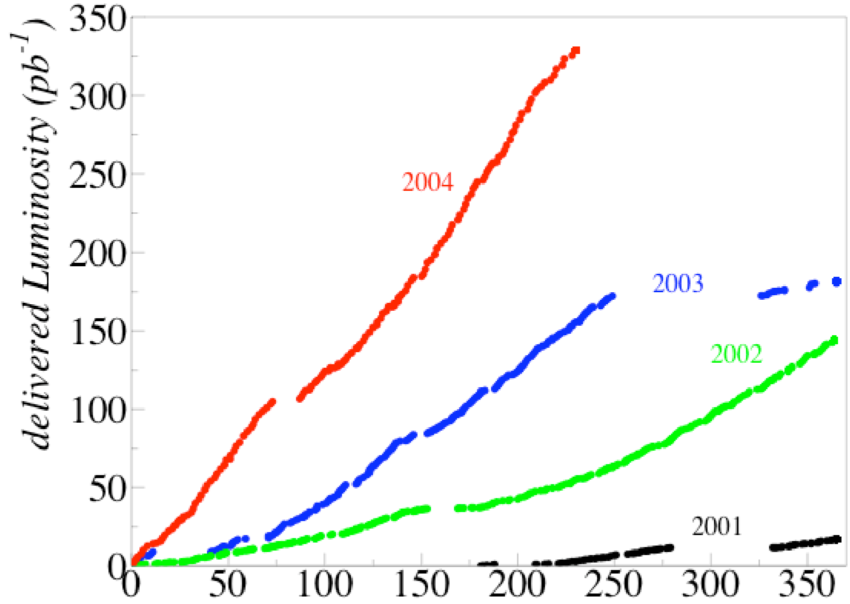
	$\sqrt{s}$(TeV)	Δt(ns)	L($cm^{-2}\ s^{-1}$)
Run I	1.8	3500	2.5×10^{31}
Run II	1.96	396	1.0×10^{32}

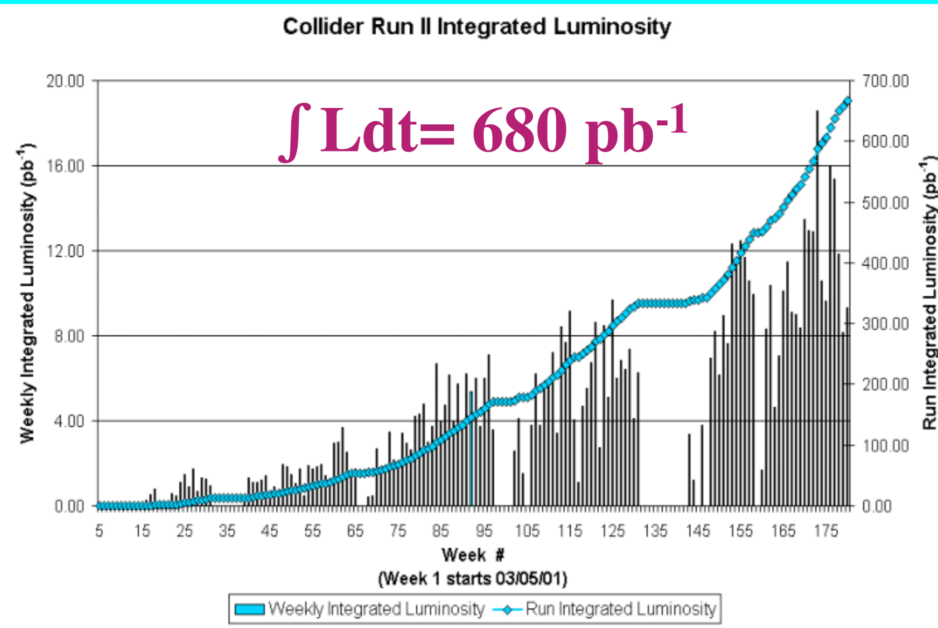
- Experiment CDF:
  - New tracking systems
  - New Time-of-flight detector
  - New forward calorimeter
  - New RO electronics+trigger
  - Many other substantial new components and upgrades

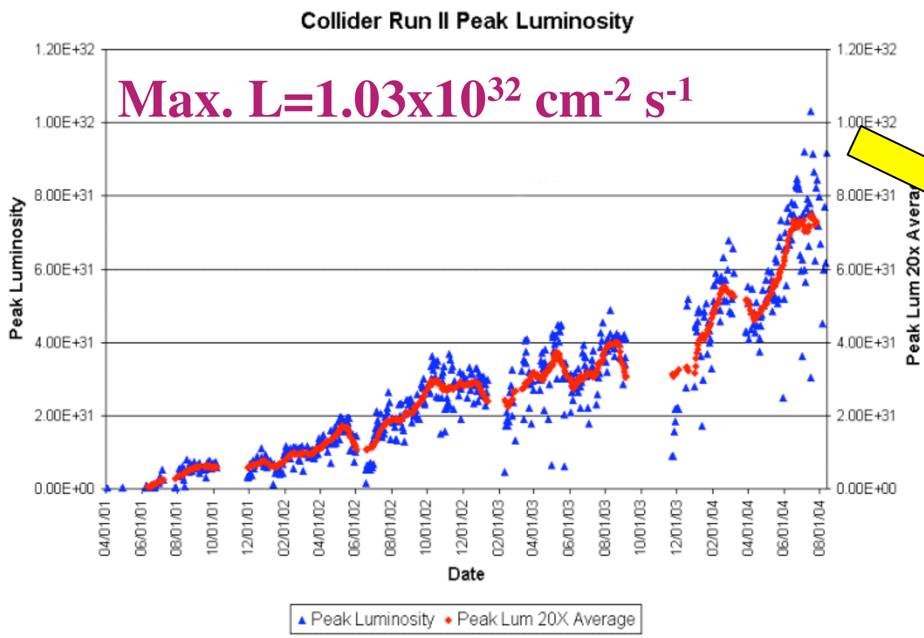




Tevatron Performance



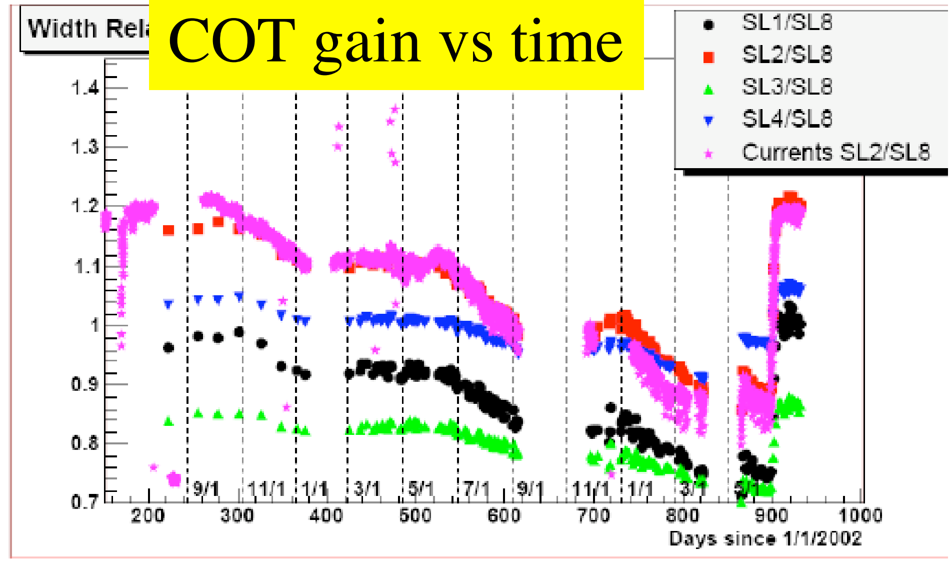




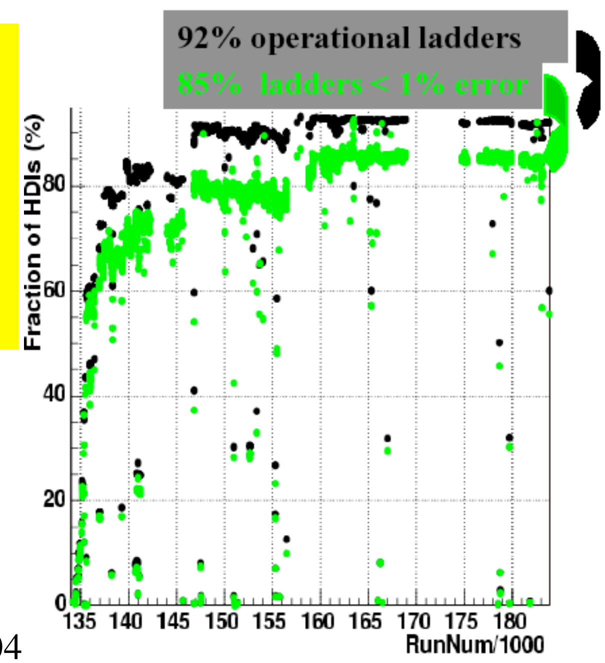
CDF Performance

-CDF takes high quality data (85%)
-Initial problems with Silicon operation largely solved
-Recent problems with tracking drift chamber solved (gain recovered)

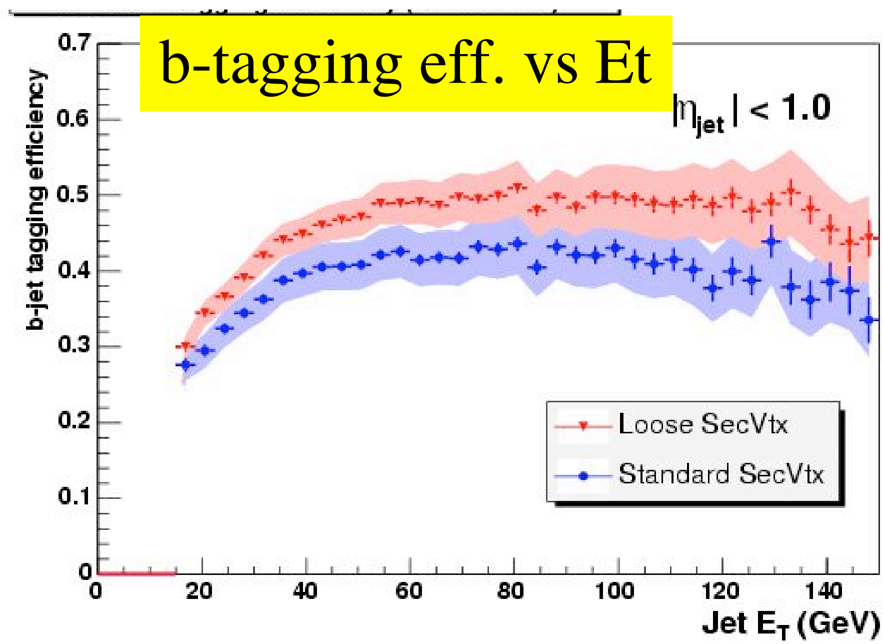
COT gain vs time



Silicon Detector Efficiency vs time

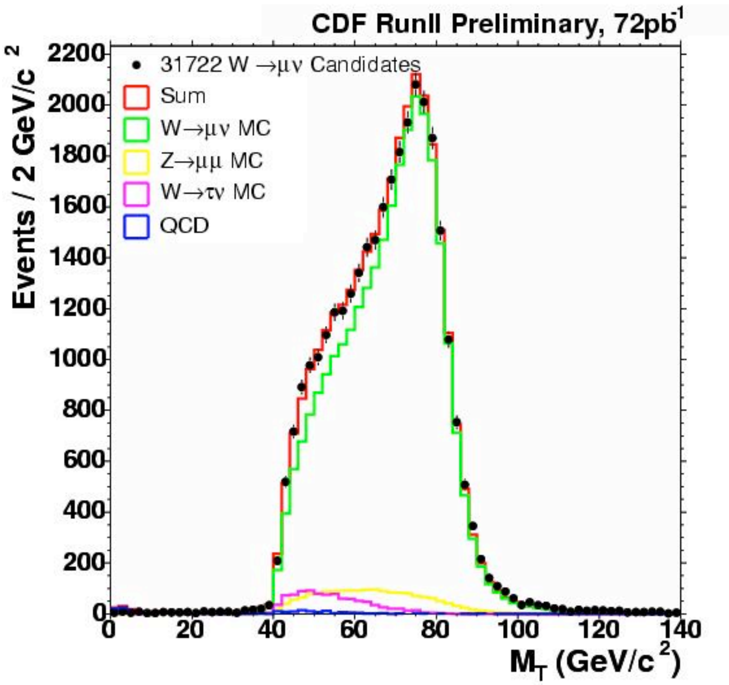


b-tagging eff. vs Et



Inclusive W cross section

- W→μν and W→eν signal:
- Backgrounds from jets, Drell-Yan, W→τν and cosmic μ's
- Excellent description by MC simulation



Candidate events in $72pb^{-1}$		Estimated background	Acceptance x efficiency
W →eν	31,722	(10.6 ± 0.4)%	(17.9±0.3)%
W→μν	37,574	(4.4 ± 0.8)%	(14.4±0.3)%

$$M_T = \sqrt{E_T(l)\cdot E_T(\nu) - p_x(l)\cdot p_x(\nu) - p_y(l)\cdot p_y(\nu)}$$

- Total inel. pp cross section measurement used for luminosity:
  - error weighted average of CDF and E811: σ=59.3+-2.3 mb at √s=1.8 TeV

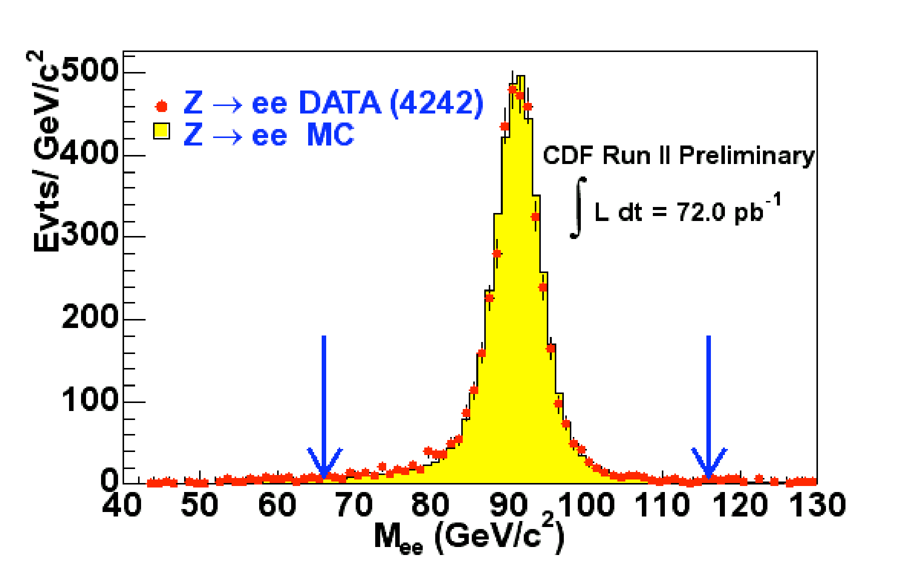
W. van Neerven, J. Stirling

NNLO σ=2687+-54 pb

σ(pp→W →lν) = 2775 ±10(stat) ± 53 (syst) ±167 (lum) pb

Z Production Cross Section

- $Z/\gamma^* \to e^+ e^-$ and $Z/\gamma^* \to \mu^+\mu^-$
- $66 < m(\gamma\,\gamma)/\mathrm{GeV}c^{-2} < 116$
- Small backgrounds from jets, $Z/W \to \tau$, cosmics μ's:
  - less than 1.5%



Number of events in $72\mathrm{pb}^{-1}$		acceptance x efficiency
$Z/\gamma^* \to e^+ e^-$	4242	(22.7+-0.5)%
$Z/\gamma^* \to \mu^+\mu^-$	1785	(10.2+-0.3)%

W. van Neerven, J. Stirling

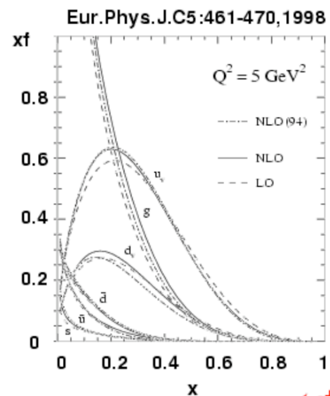
NNLO σ= 251.3+-5.0 pb

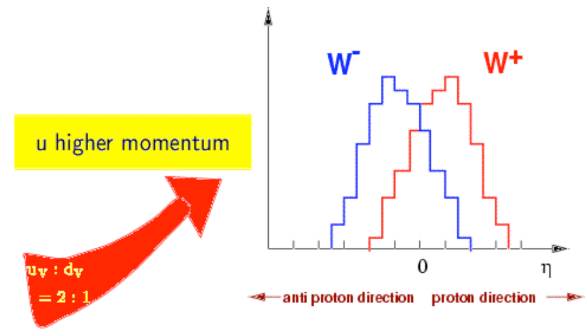
For $66<m(l^+l^-)<116\ \mathrm{GeV}/c^2$:

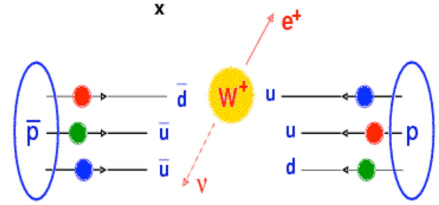
$\sigma(pp \to Z/\gamma^* \to l^+l^-) = 254.9 \pm 3.3(\mathrm{stat}) \pm 4.6\ (\mathrm{syst}) \pm 15.2\ (\mathrm{lum})$ pb

W Charge Asymmetry

- Sensitive to derivative of d/u at x≈0.1
- Used by CTEQ and MRST global fits
- Experimentally:
  - Using new forward silicon and calorimeters
  - Precision measurement, i.e. good understanding of systematic errors required



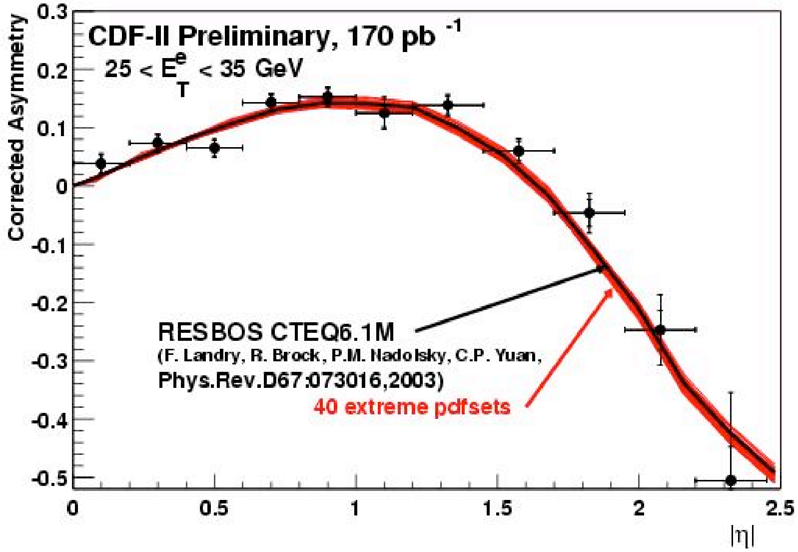


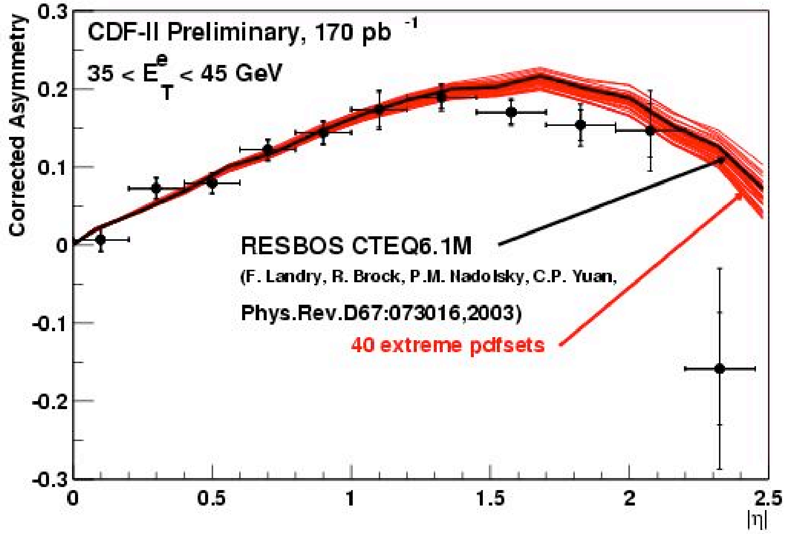


W^+ boosted in p direction
W^- boosted in $\bar{p}$ direction

$$A_l(\eta) = \frac{d\sigma(e^+)/d\eta - d\sigma(e^-)/d\eta}{d\sigma(e^+)/d\eta + d\sigma(e^-)/d\eta} \simeq \frac{d(x)}{u(x)}$$

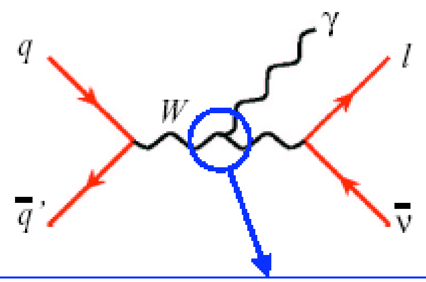
New Run 2 data: two Pt bins





- Et dependence of asymmetry not well modelled by CTEQ6 PDF's (they were fit to the average): will check MRST
- Data provide new PDF constraints

Anomalous Couplings

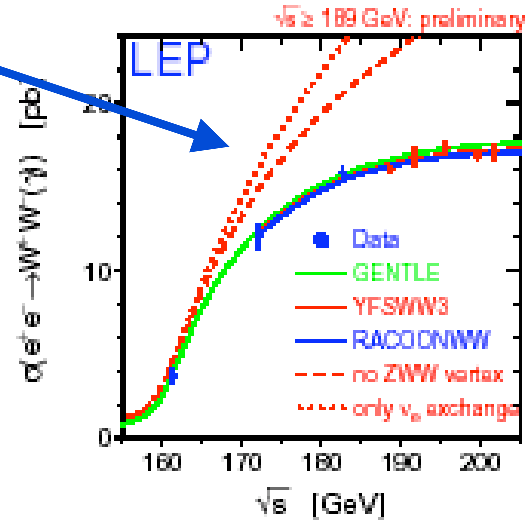


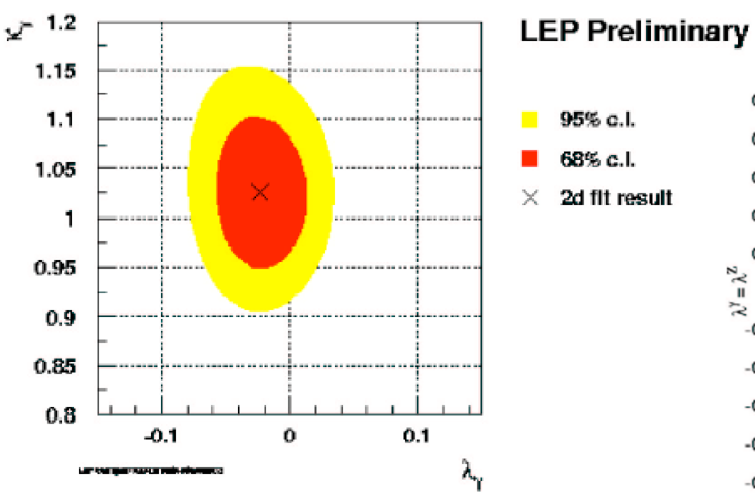
Anomalous couplings : Δκ, λ

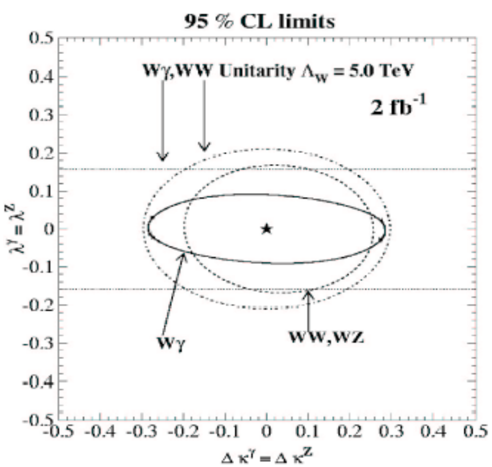
$$\mu_W = e(1+\kappa_\gamma+\lambda_\gamma)/2m_W$$

$$q_W = -e(\kappa_\gamma-\lambda_\gamma)/m_W^2$$

Existence of WWγ vertex indirectly seen at LEP







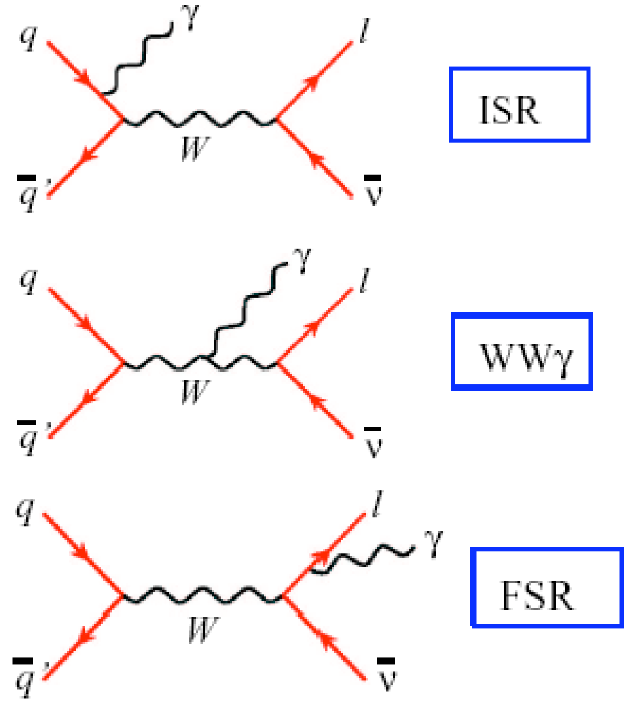
LEP results hard to beat but complementary:

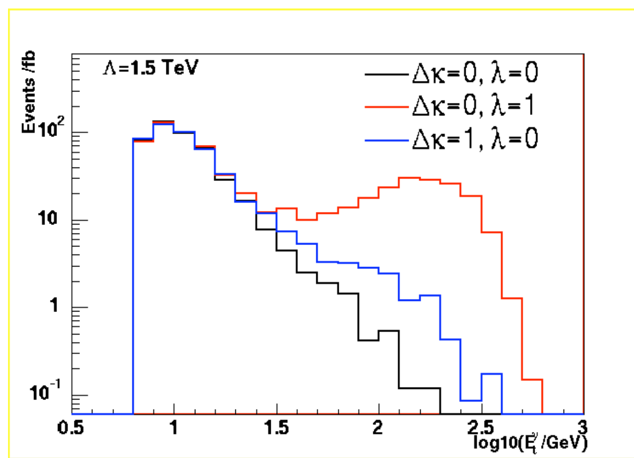
✓higher energy

✓WWγ vs WWZ

W/Z+γ Production

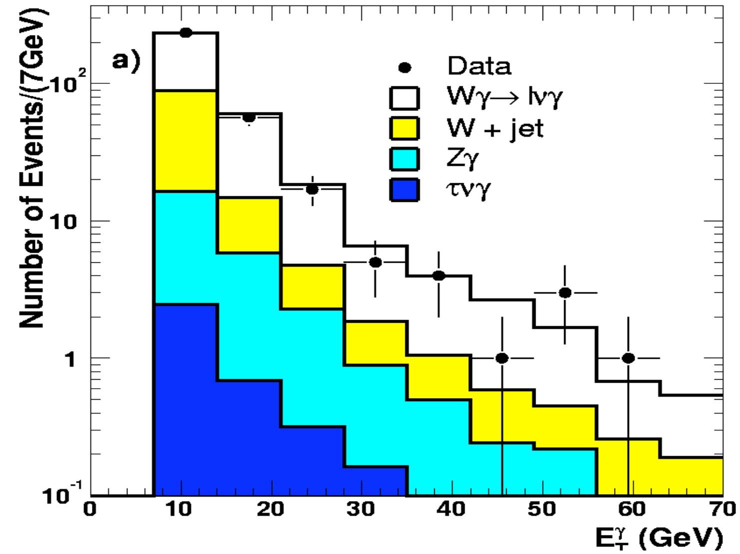
- s-channel diagram:
  - Sensitive to trilinear gauge coupling WWγ
  - Not present in SM for Zγ
- Selection
  - W's and Z's as in incl. cross section measurement
  - Photon Et>7 GeV
  - Main background: leading π^0's
- Anomalous couplings:
  - Harder photon Et spectrum

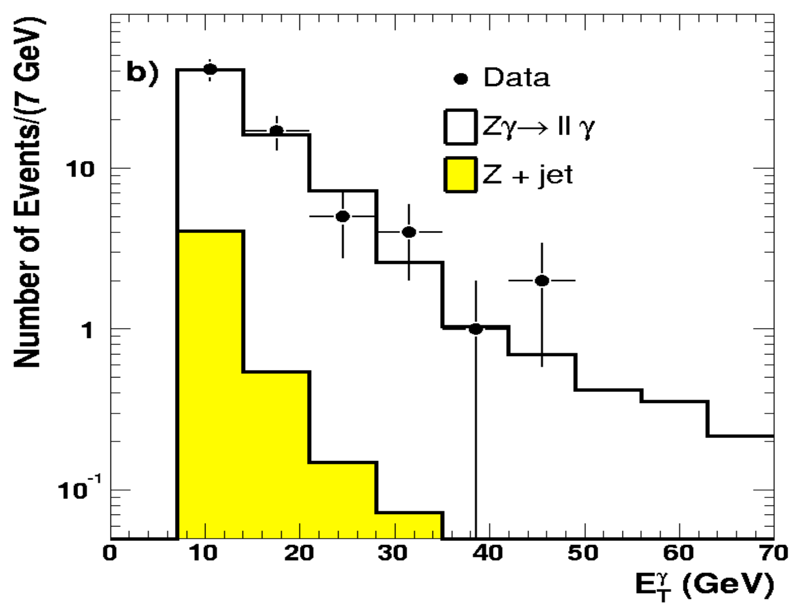




Wγ and Zγ: Photon E_t

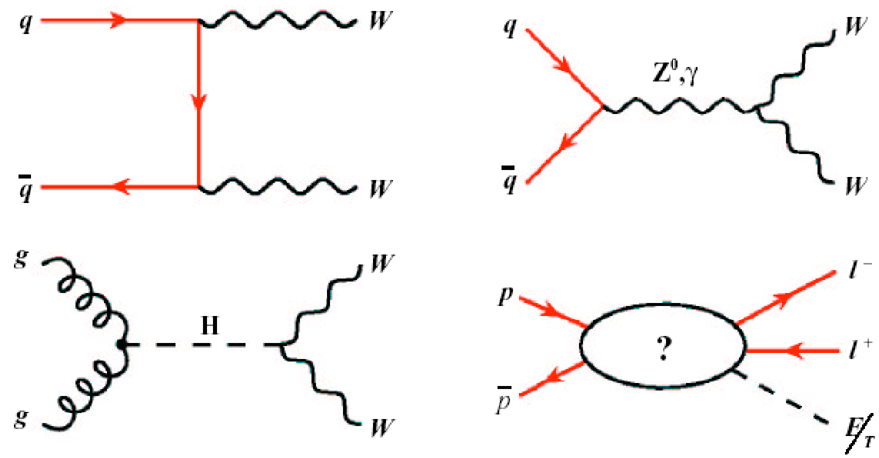
- Wγ cross section:
  - CDF Data: 18.1+-3.1 pb
  - NLO(U. Baur):19.3+-1.4 pb
- Zγ cross section:
  - CDF Data: 4.6+-0.6 pb
  - NLO(U. Baur): 4.5+-0.3 pb
- Data agree well with SM
- Soon: extract WWγ and ZZγ couplings

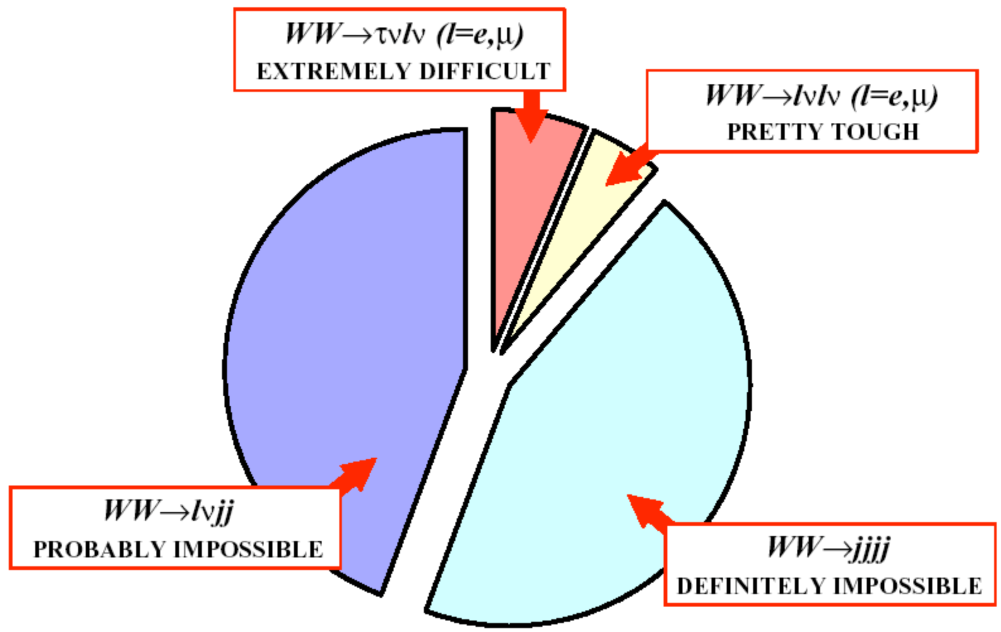




WW Production

- Why?
  - Never observed at hadron colliders with any significance (run 1: 5 observed / 1.2+-0.3 BG)
  - SM test, anomalous copulings
  - Higgs -> WW
- How?
  - WW->lvlv channel best but branching ratio small
  - Require
    - 2 leptons (Pt>20 GeV)
    - large Et
    - Njet(Et>15 GeV)=0 to suppre top background





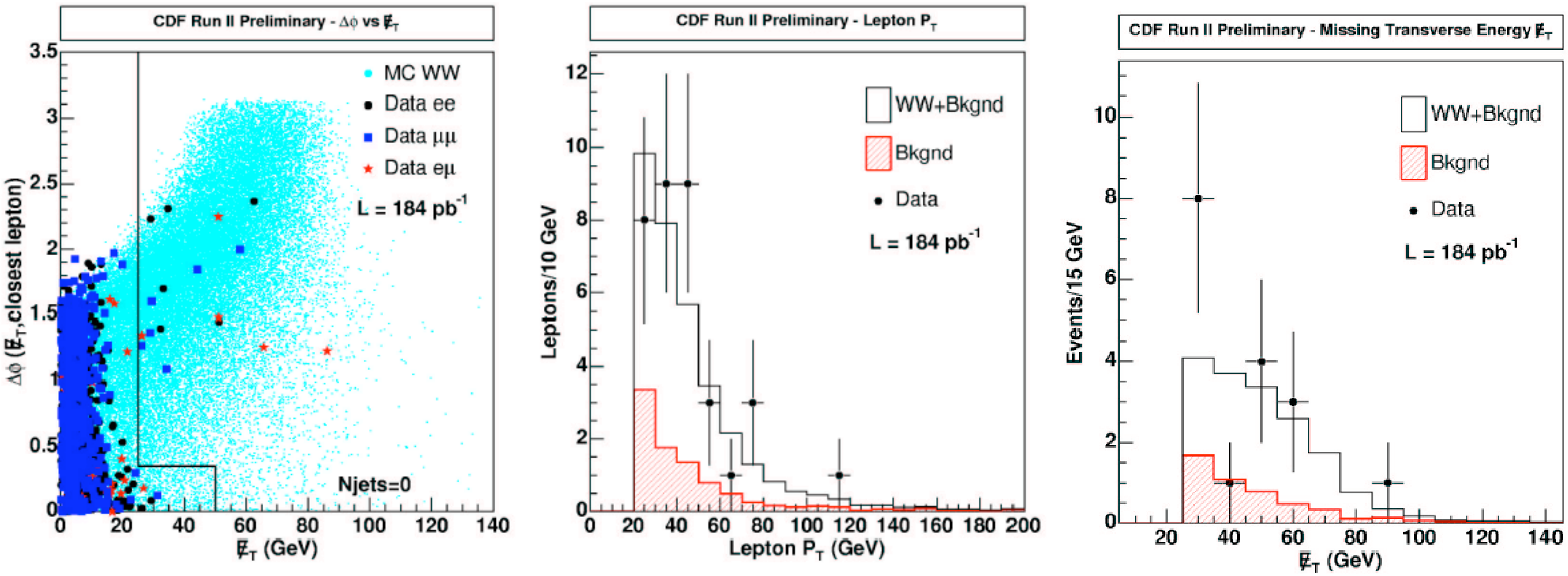
WW: Cross Section Results

	"Dilepton"	"Lepton+track"
WW signal	11.3+-1.3	16.3+-0.4
background	4.8+-0.7	15.1+-0.9
Expected	16.1+-1.6	31.5+-1.0
Observed	17	39
Cross Section	14.3+-5.9	19.4+-6.3

- 2 independent analysis (high purity vs high acceptance) =>Consistent results
- First significant signal: significance>3σ
- Agree with theor. prediction: σ_{NLO} = 12.5+-0.8 pb

Campbell & Ellis

WW kinematic distributions



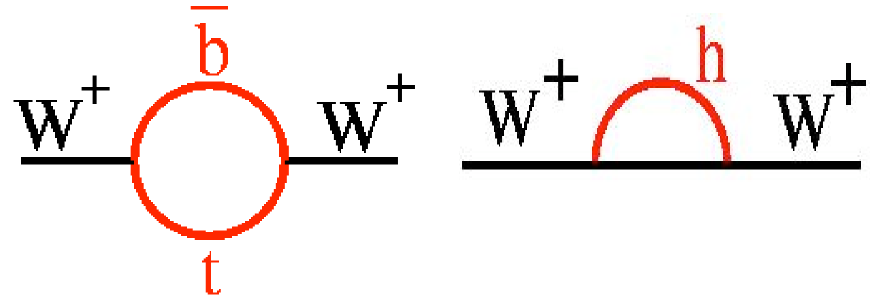
- Kinematic properties as expected from SM WW production
- => use the data to constrain new physics

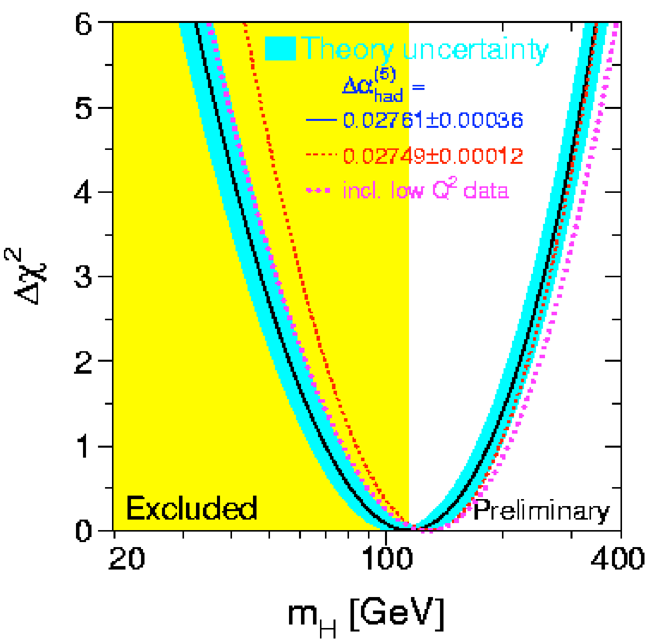
Higgs

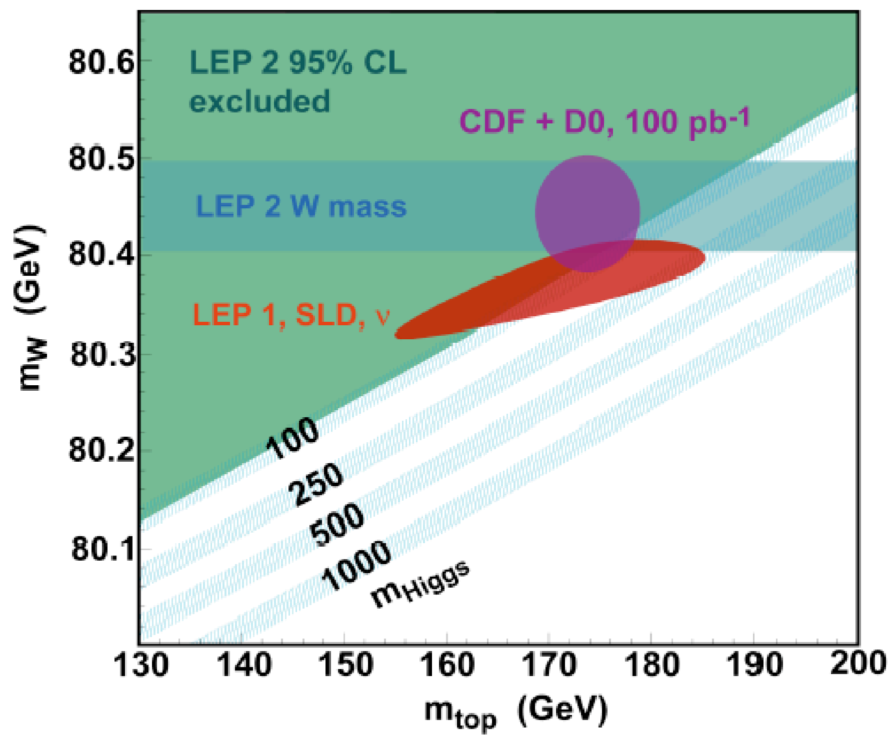
The Higgs boson: what do we know?

- Precision measurements of
  - M_W =80.412 ± 0.042 GeV/c²
  - M_{top}=178.0 +- 4.3 GeV/c²
- Prediction of higgs boson mass within SM due to loop corrections
  - Most likely value: 114 GeV
- Direct limit (LEP): m_h>114.4 GeV

m_W depends on m_t and m_h







W boson and top quark mass

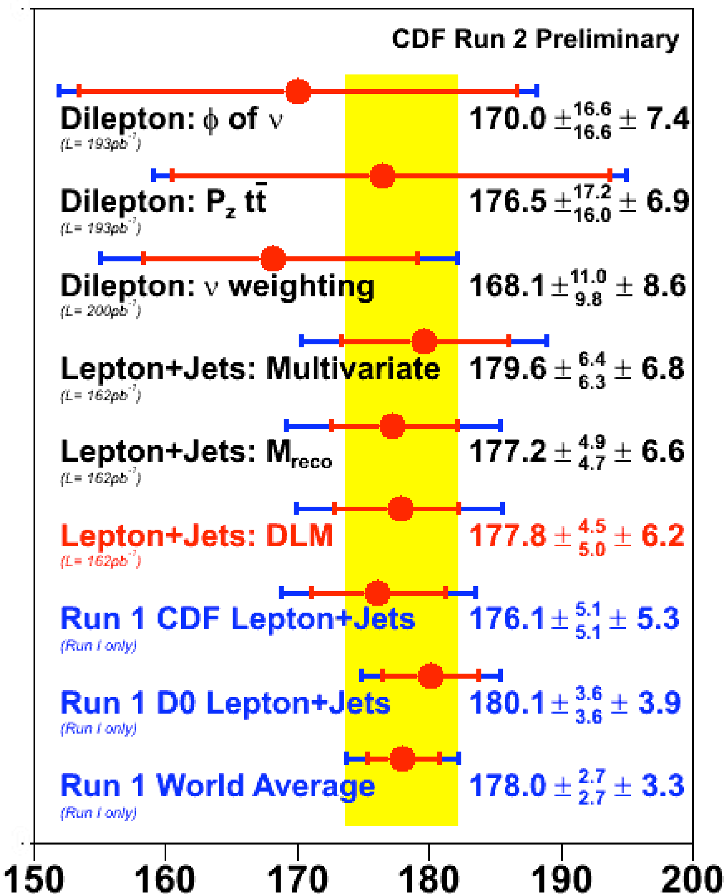
W mass: current error estimated (analyses still “blinded”)

Systematic	Electrons (Run 1b)	Muons (Run 1b)
Lepton Energy Scale and Resolution	70 (80)	30 (87)
Recoil Scale and Resolution	50 (37)	50 (35)
Backgrounds	20 (5)	20 (25)
Statistics	45 (65)	50 (100)
Production and Decay Model	30 (30)	30 (30)
Total	105 (110)	85 (140)

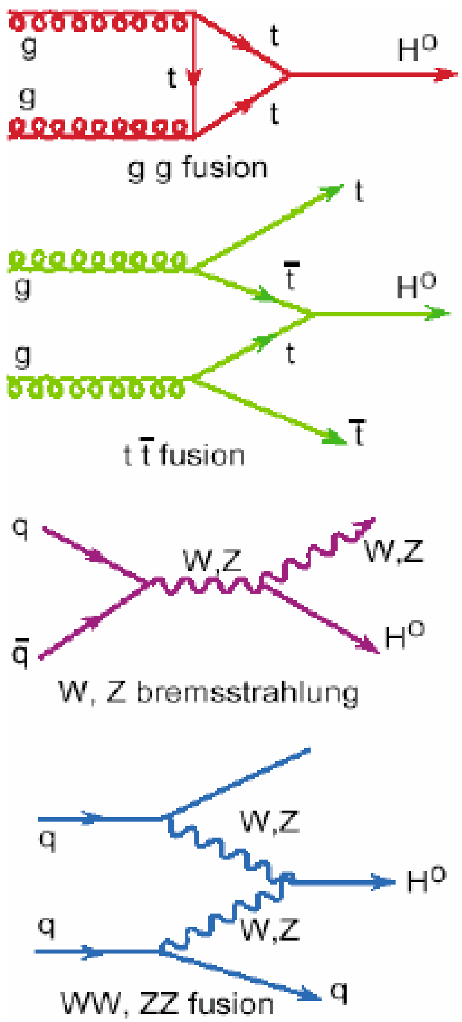
CDF RUN II PRELIMINARY

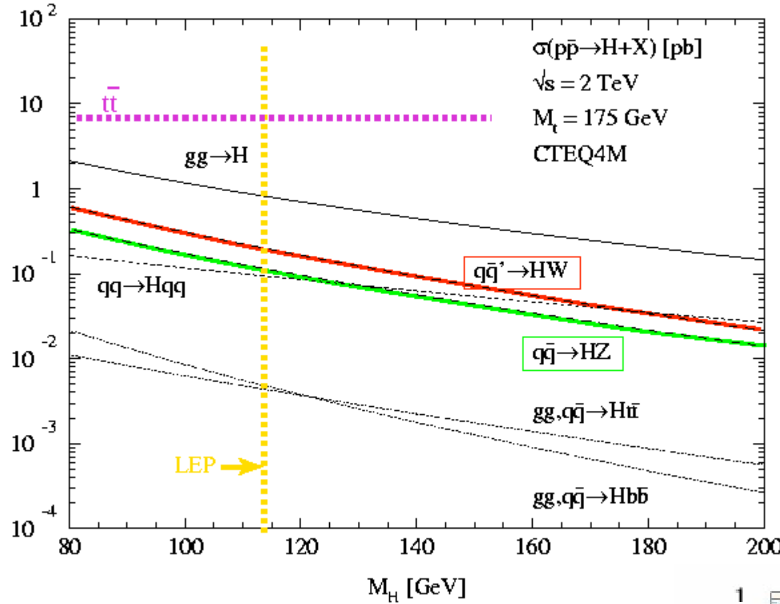
- Top and W mass measurements in progress:
  - Expect improvement w.r.t. Run I by winter conferences
    - Major effort on dominant jet energy scale error
    - => reducing now from ≈5-8% to ≈2.5-4% (at E_t>40 GeV, larger at lower E_t)

top mass:many measurements



Higgs Production and Decay





Dominant Production:
gg-> H

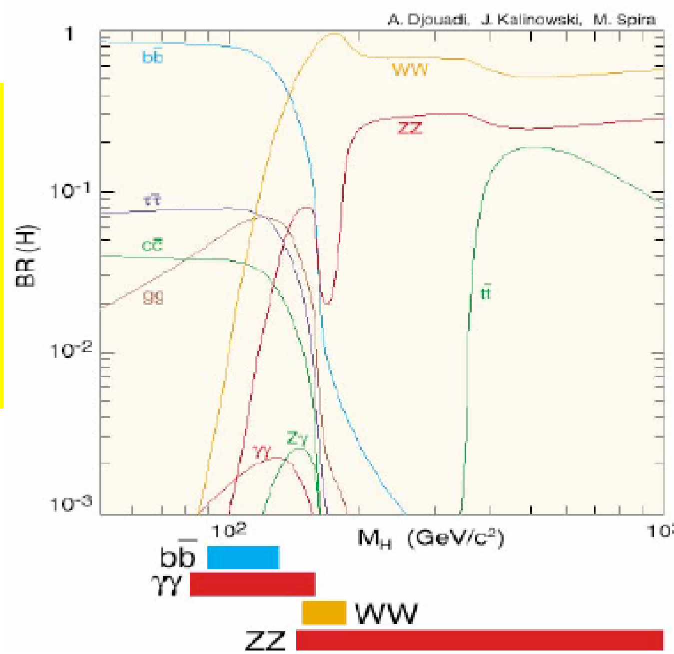
subdominant:

HW, Hqq

Dominant decay:

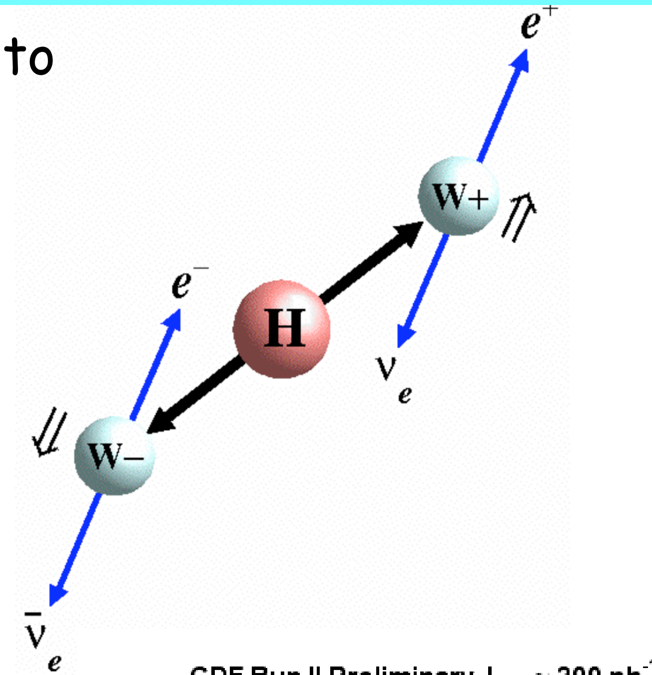
-low mass: bb, ττ

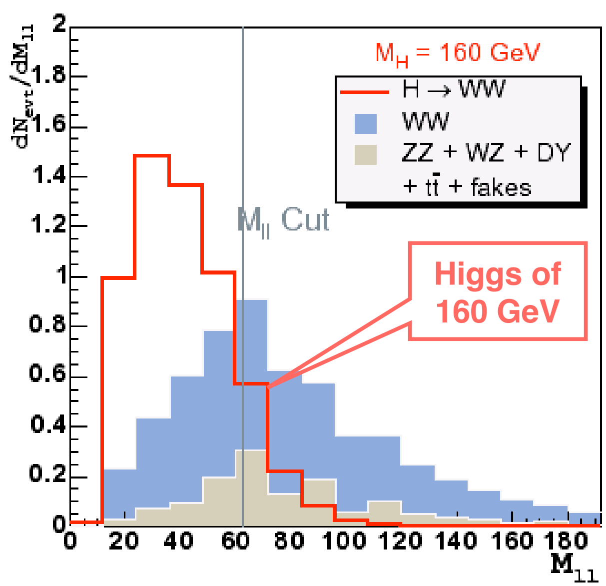
-High mass: WW,ZZ



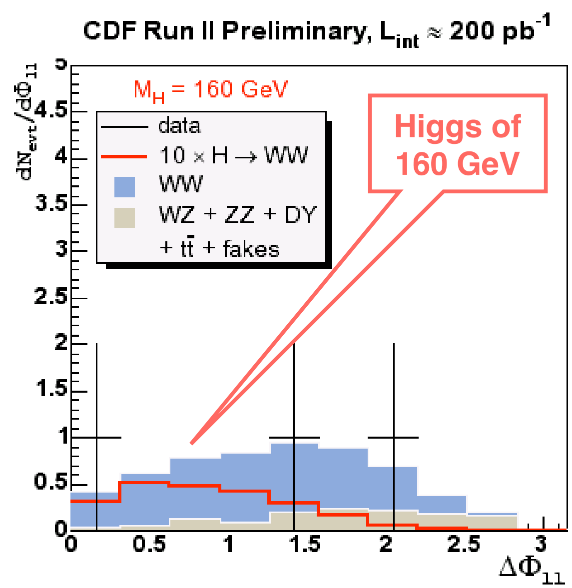
$H \to WW^{(*)} \to l^+l^-\nu\nu$

- Higgs mass reconstruction not possible due to two neutrions:
  - Dilepton mass lower for h->WW: mass dependent cut
- Employ spin correlations to suppress WW background:
  - leptons from $h \to WW^{(*)} \to l^+l^-\nu\nu$ tend to be collinear





M_H	Cut
140 GeV	$M_{ll} \leq$ 55.0 GeV
150 GeV	$M_{ll} \leq$ 57.5 GeV
160 GeV	$M_{ll} \leq$ 62.5 GeV
170 GeV	$M_{ll} \leq$ 70.0 GeV
180 GeV	$M_{ll} \leq$ 80.0 GeV

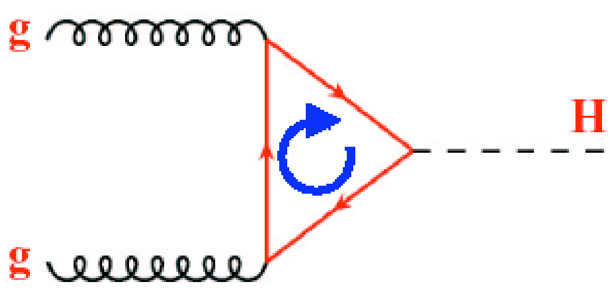


$H \rightarrow WW^{(*)} \rightarrow l^+l^-\nu\nu$

- Similar analysis by D0

D0	ee	eμ	μμ
Observed	2	2	5
Expected	2.7±0.4	3.1±0.3	5.3±0.6

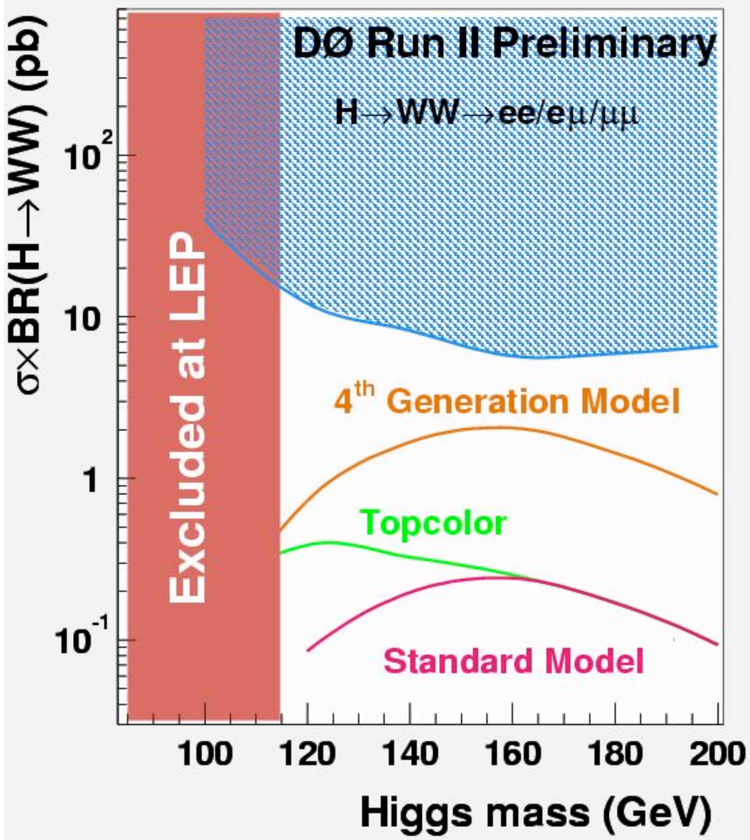
- Neither CDF nor D0 see any evidence for h production => set upper limit on cross section



$\sigma(gg \rightarrow H; 4G) \sim 9 \times \sigma(gg \rightarrow H; 3G)$

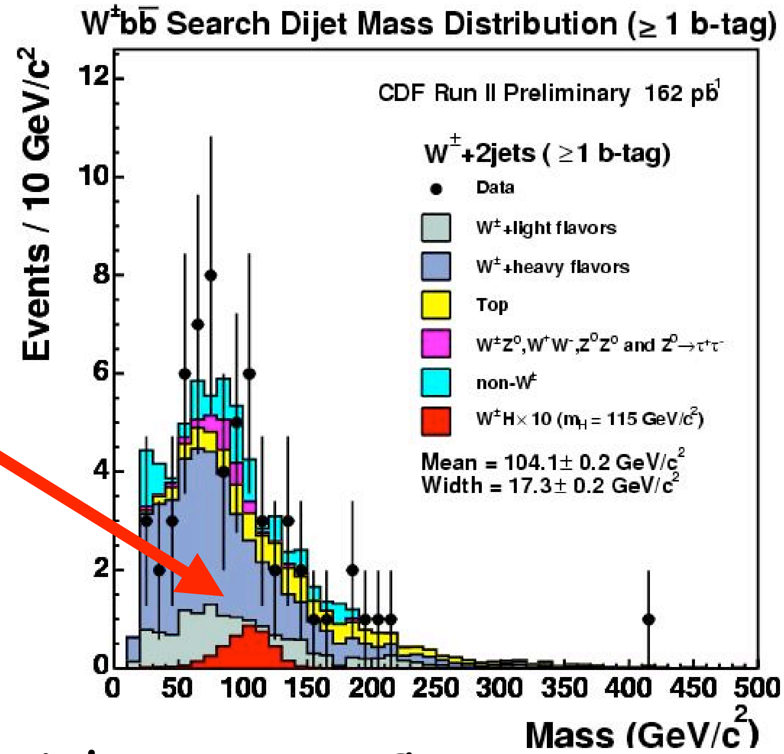
- Expect 0.11 events for 160 GeV SM Higgs with 200/pb

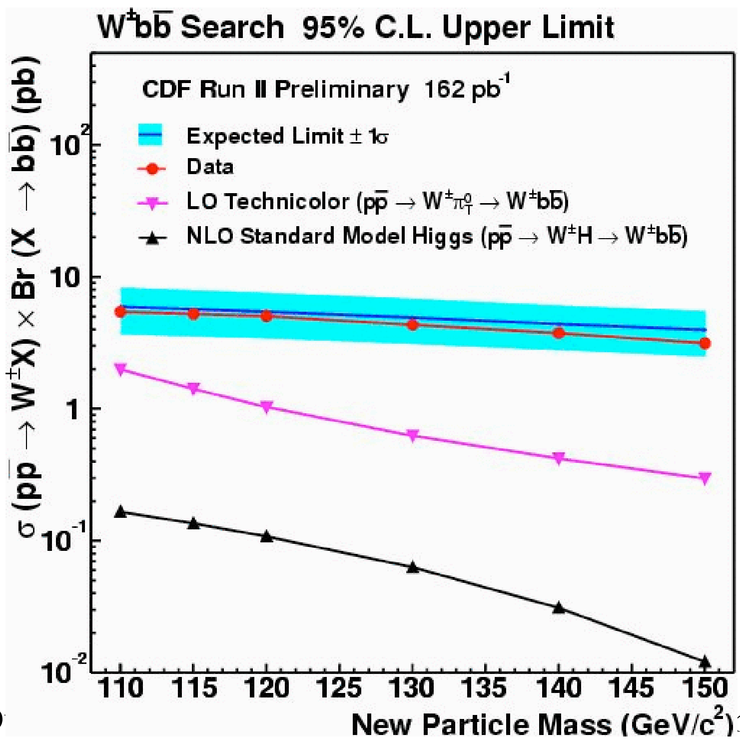
Excluded cross section times Branching Ratio at 95% C.L.



Wh Production: Run 2 data

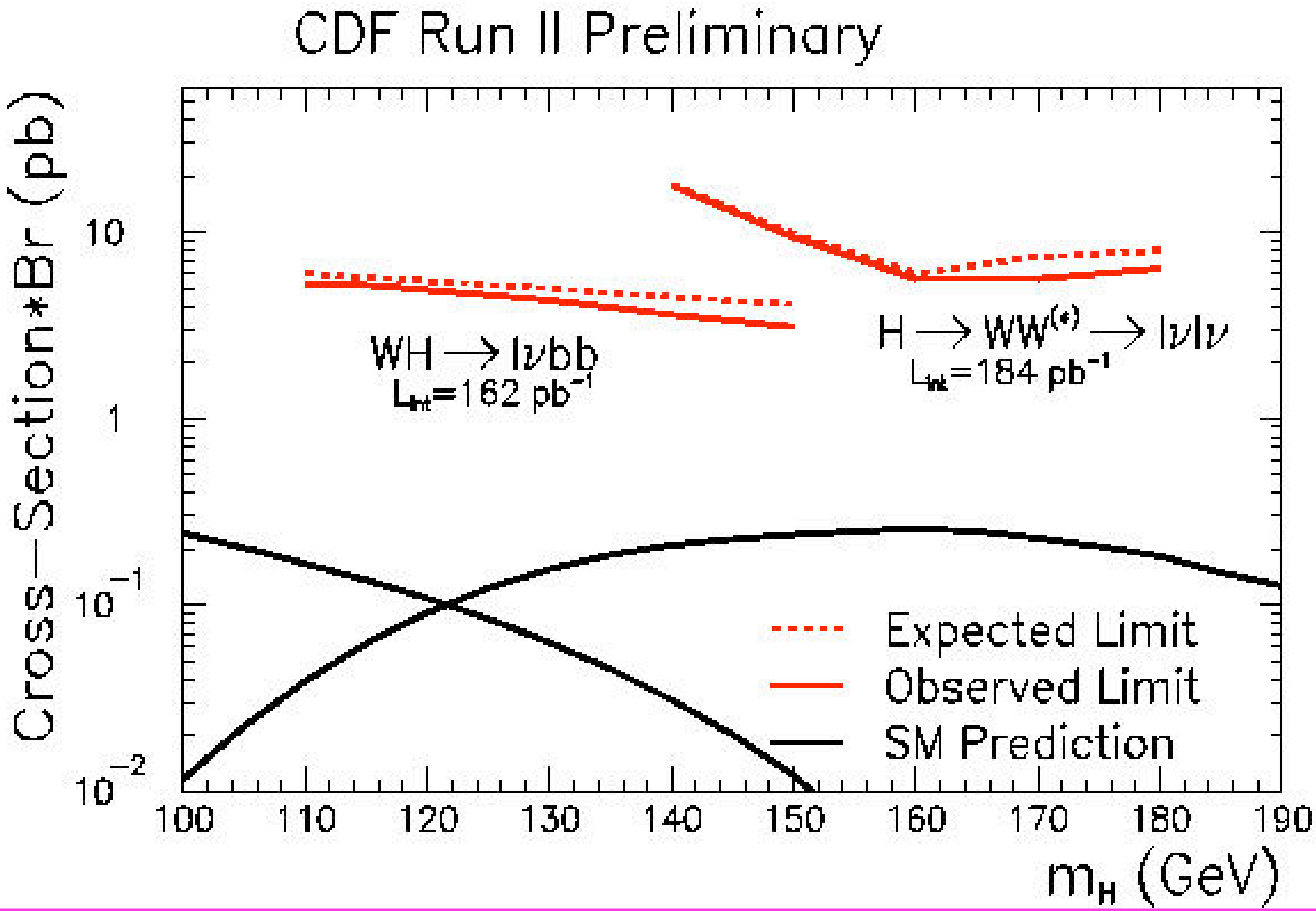
- Selection:
  - W(→μν or eν)
  - 2 jets: 1 b-tagged
- Search for peak in dijet invariant mass distribution





- No evidence => Cross section limit on
  - Wh->Wbb production
  - Techni-ρ ->Techni-π +W

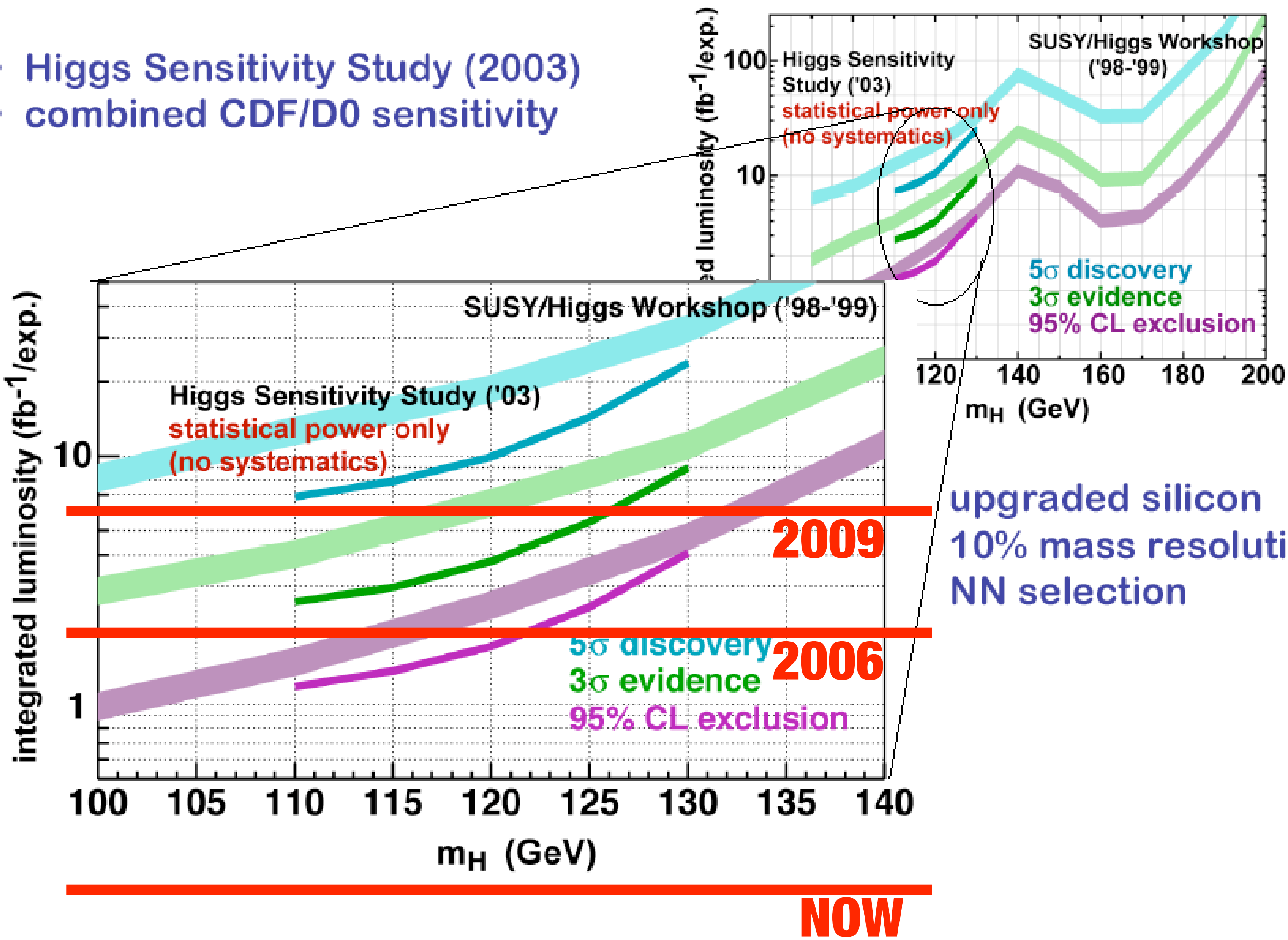
Summary of SM Higgs Searches



We are trying to close in…race against LHC:
experimental techniques continuously being improved

Higgs Discovery at Tevatron?

- Higgs Sensitivity Study (2003)
- combined CDF/D0 sensitivity

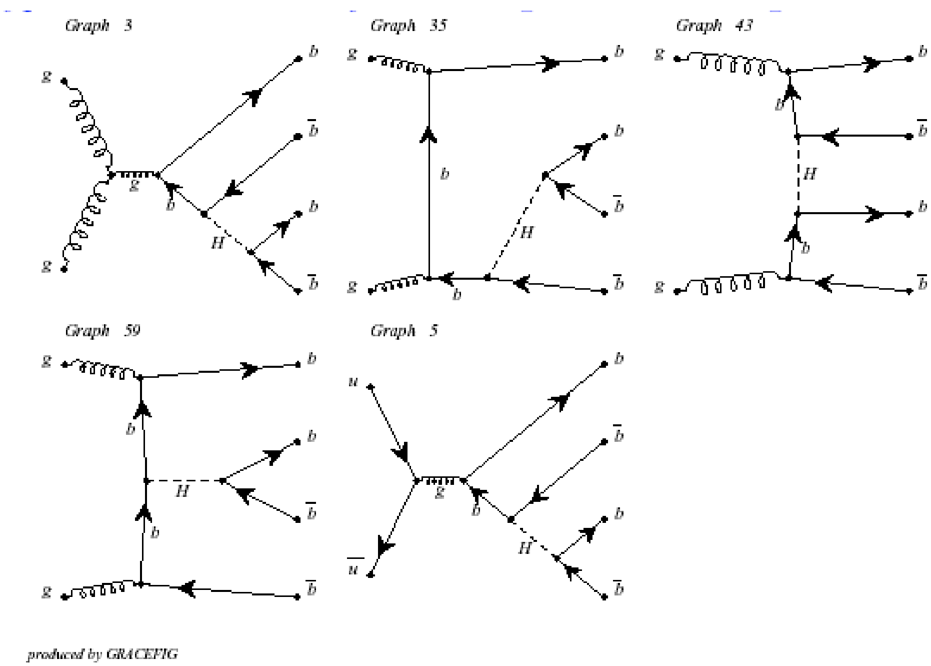


upgraded silicon
10% mass resolution
NN selection

MSSM Higgs

- In MSSM the bbA Yukawa coupling grows like $\tan^2\beta$:
  - Larger cross sections
  - Better discovery potential than SM
- Search for final states:
  - A+b+X->bbb+X
  - $A+X \rightarrow \tau\tau + X$

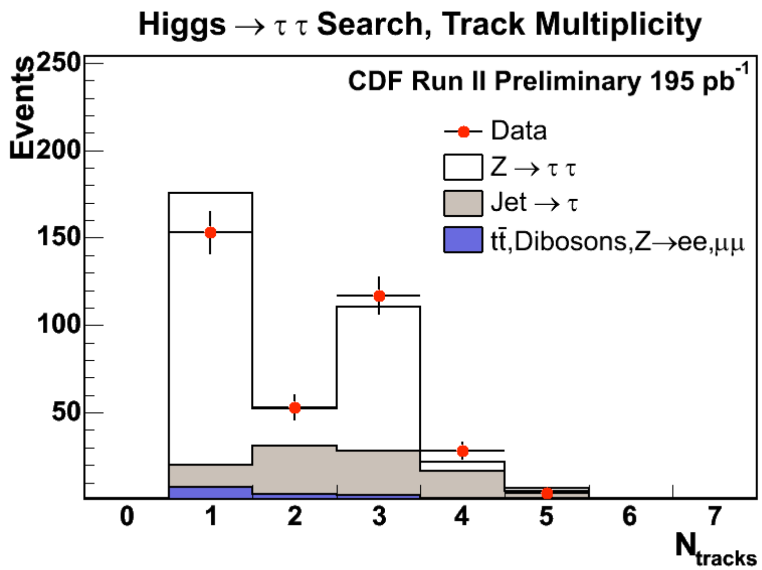
LO diagrams

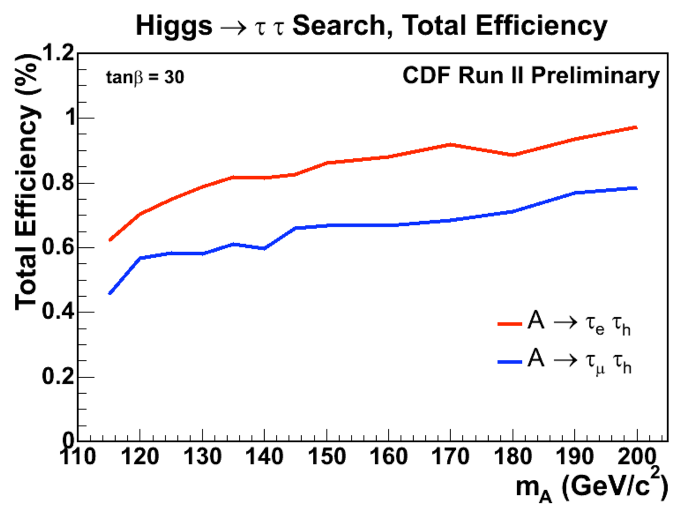


S. Willenbrock

MSSM Higgs: A -> ττ

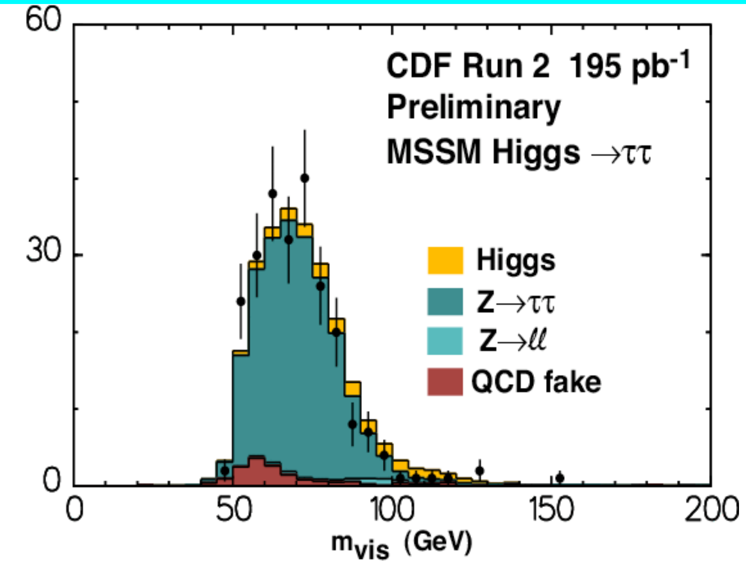
- τ's are tough!
- Select di-τ events:
  - 1 lepton from $\tau \to l\nu\nu$
  - 1 hadronic τ-decay (narrow jet)
- Efficiency ≈1%
- Background: mostly Z->ττ

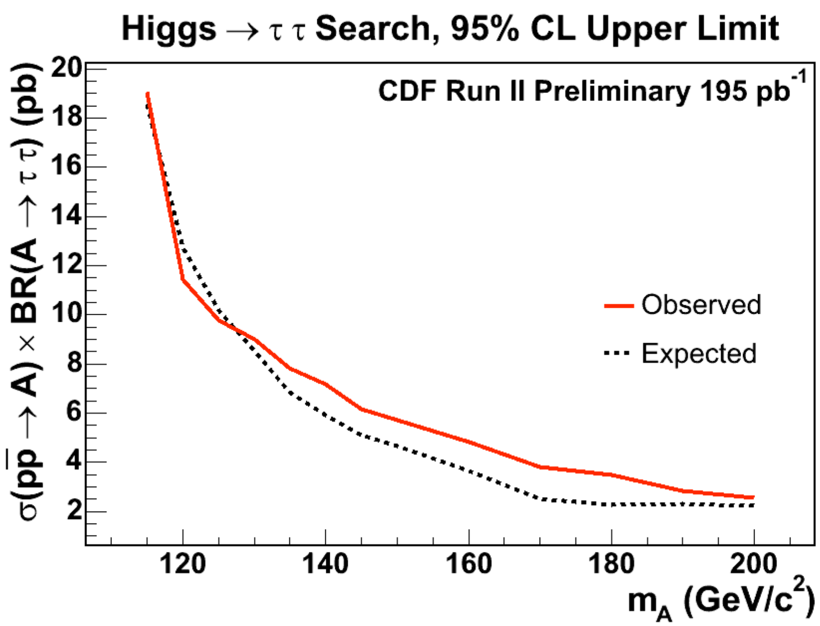


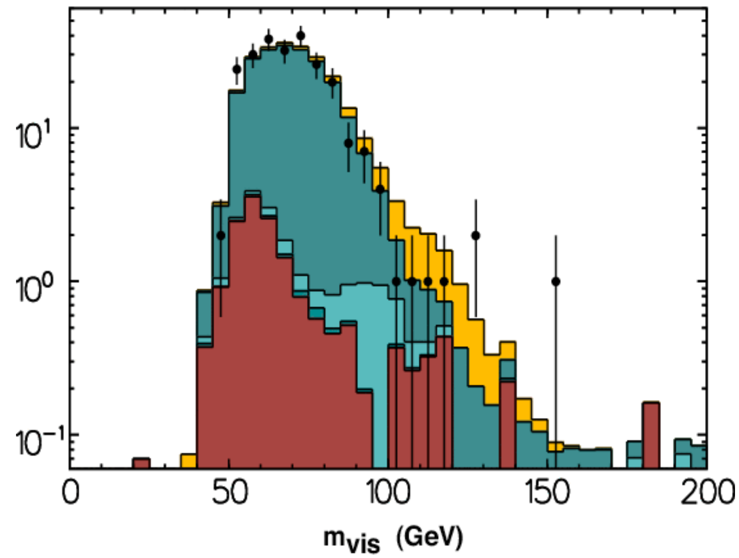


MSSM Higgs A-> ττ

- Fit "visible" mass: from leptons, tau's and $\not{E}_T$
- Limit on σxBR≈10-2 pb
- Interpretation soon in tanβ vs m_A plane

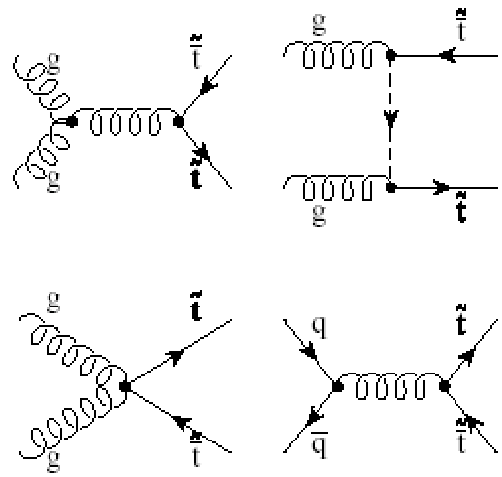


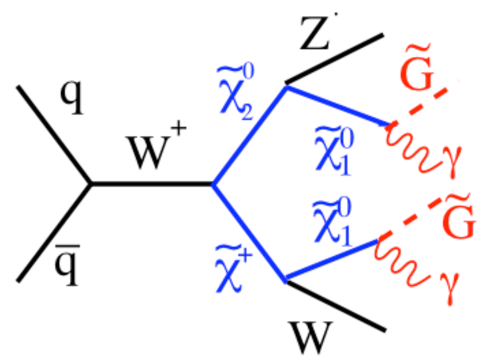




SUSY Searches

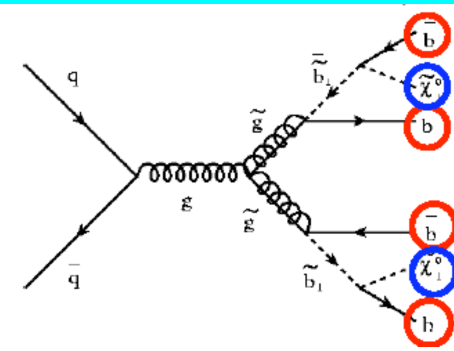
- mSUGRA inspired
  - Neutralino LSP
  - Typical signature: $\not{E}_t$
  - Best:
    - Neutralino-chargino production (not yet beating LEP)
    - Squarks: large cross sections
  - Here: stop, sbottom, $B_s \to \mu\mu$
- GMSB inspired:
  - Gravitino LSP
  - Here: Neutralino (NLSP)->$G\gamma$
  - 2 photons + $\not{E}_t$ + X

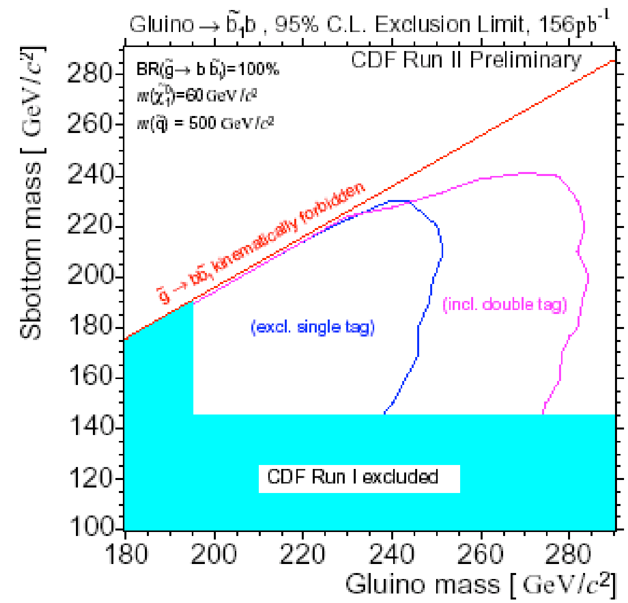




Bottom Squarks

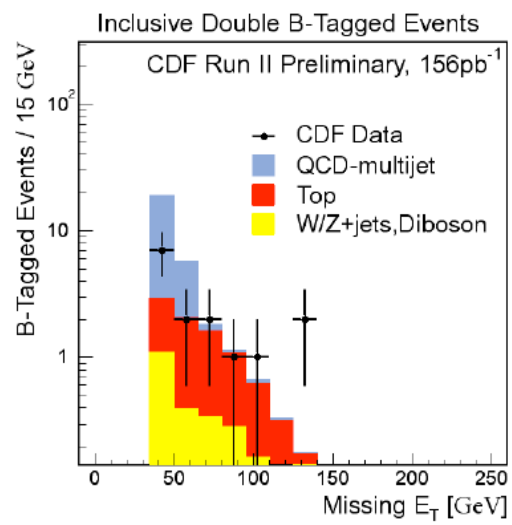
- High tanβ scenario:
  - Sbottom could be "light"
- This analysis:
  - Gluino rather light: 200-300 GeV
  - $BR(\tilde{g}\text{->}\tilde{b}b)$~100% assumed
- Spectacular signature:
  - 4 b-quarks + $\not{E}_T$
- Require b-jets and $\not{E}_T$>80 GeV





Expect:2.6±0.7

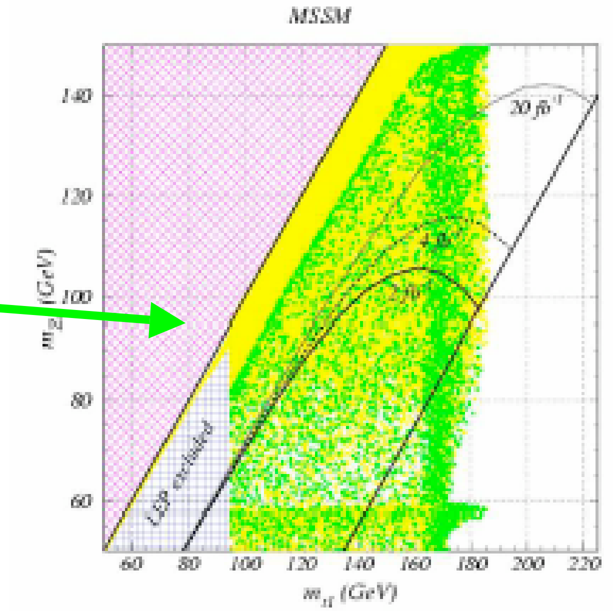
Observe: 4

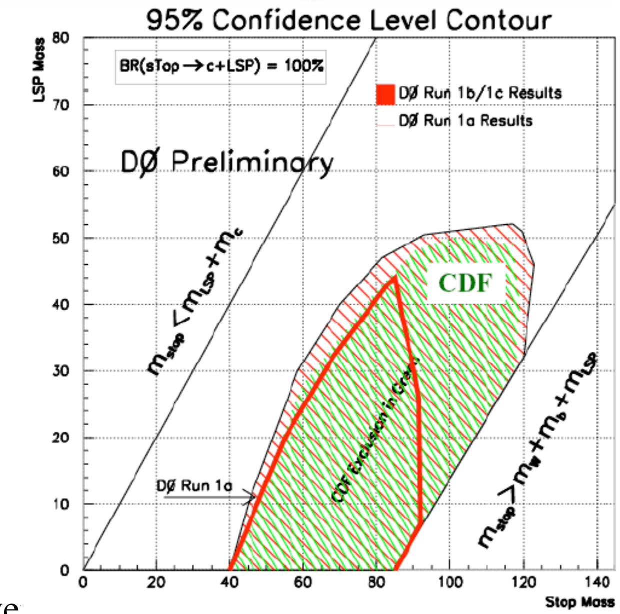


Exclude new parameter space in gluino vs. sbottom mass plane

Light Stop-Quark: Motivation

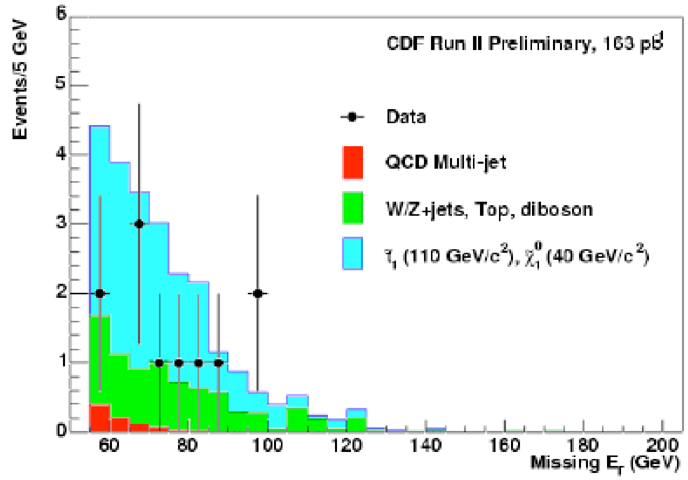
- If stop is light: decay only via t->$c\chi_1^0$
- E.g. consistent with relic density from WMAP data
  - hep-ph/0403224 (Balazs, Carena, Wagner)
  - Ω_{CDM}=0.11+−0.02
  - M(t)-M(χ_1^0)≈15-30 GeV
- Search for 2 charm-jets and large $\not{E}_t$:
  - E_t(jet)>35, 25 GeV
  - $\not{E}_t$>55 GeV

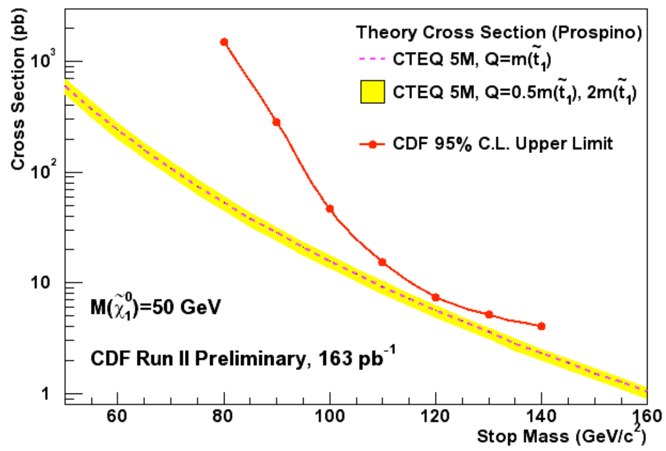




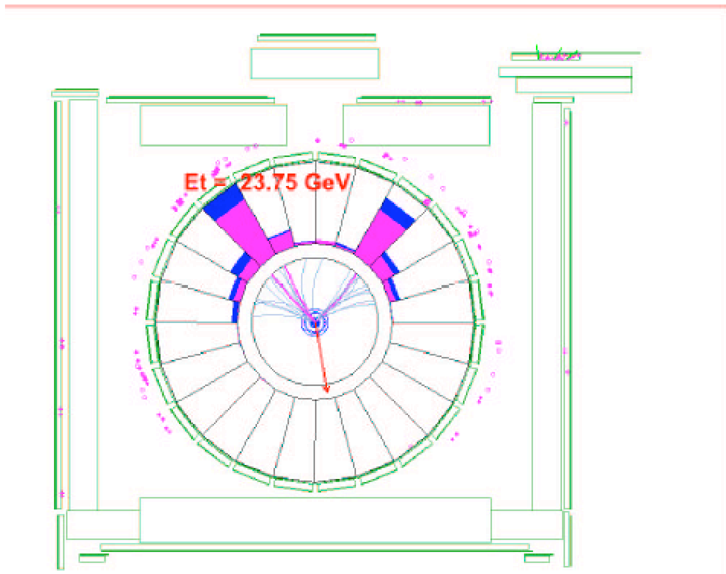
Light Stop-Quark: Result

- Data consistent with background estimate
  - Observed: 11
  - Expected: $8.3^{+2.3}_{-1.7}$
- Main background:
  - Z+ jj -> ννjj
  - W+jj -> τνjj
- Systematic error large: ≈30%
  - ISR/FSR: 23%
  - Stop cross section: 16%
- Not quite yet sensitive to MSugra cross section





Stop Candidate event



Event Display

Run: 160591 Evt: 1361839

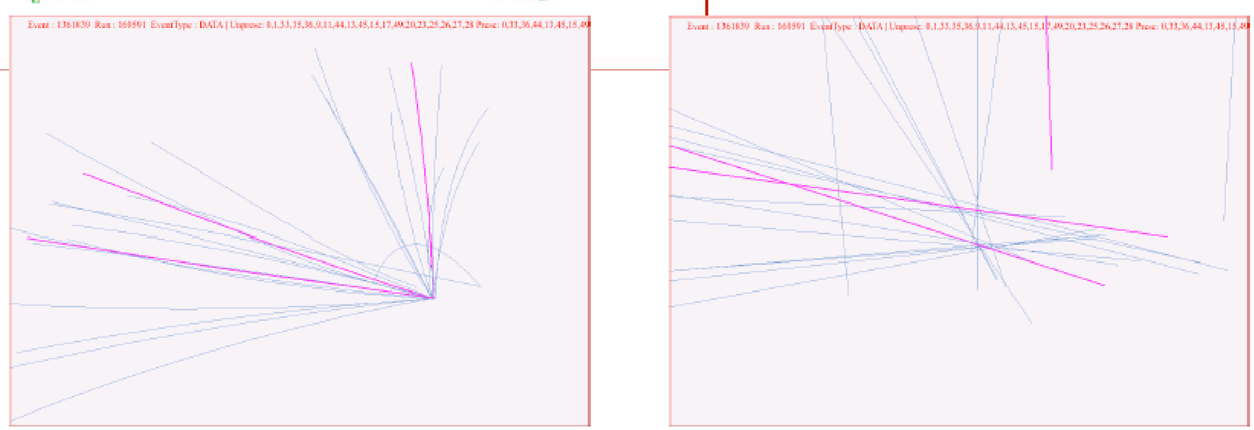
MET=59.3 GeV

Et1=41.8 GeV

Et2=31.4 GeV

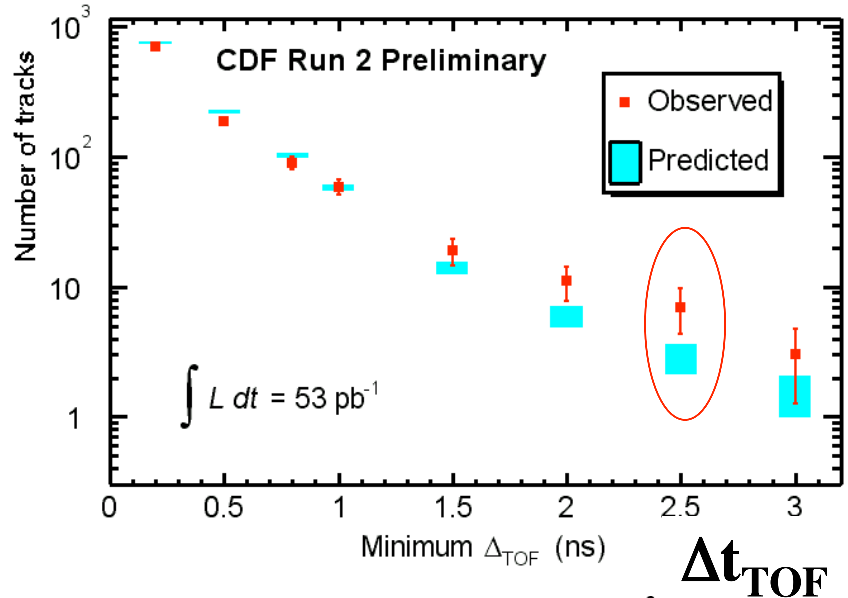
JP(1)=5.2e-5

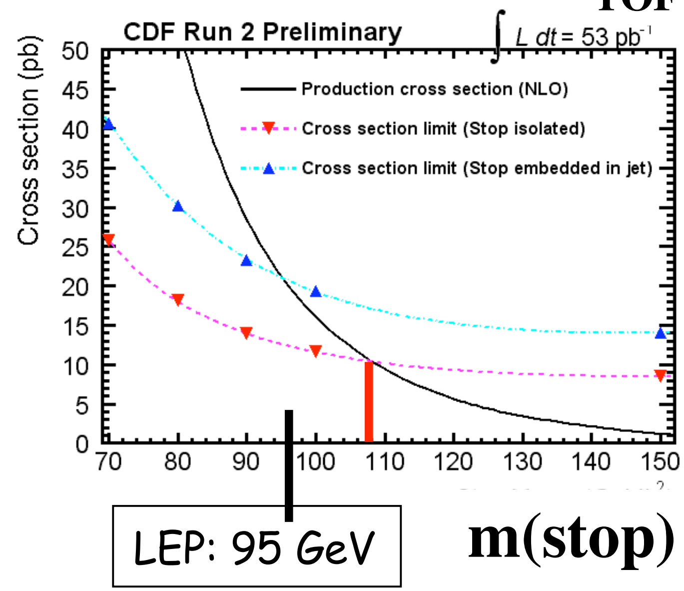
JP(2)=1.5e-4



Quasi-stable Stop Quarks

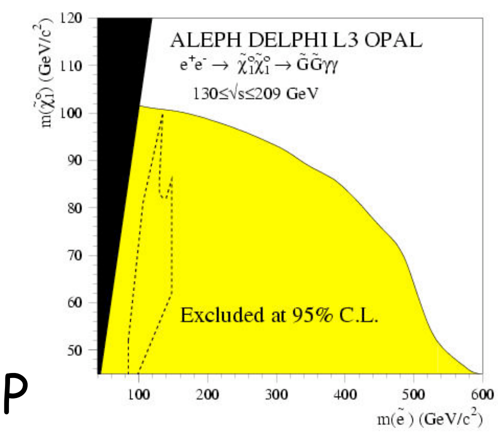
- Model:
  - any charged massive particle (e.g. stop, stau) with long lifetime: "quasi-stable"
  - Assume: fragments like b-quark
- Signature
  - Use Time-Of-Flight Detector:
    - $R_{TOF} \approx 140$cm
    - Resolution: 100ps
  - Heavy particle=> v<<c
  - $\Delta t_{TOF} = t_{track} - t_{event}$ = 2-3 ns
- Result for Δt_{TOF} >2.5 ns:
  - expect 2.9±3.2, observe 7
- σ<10-20pb at m=100 GeV
- $M(\tilde{t})$>97-107 GeV @ 95%C.L.

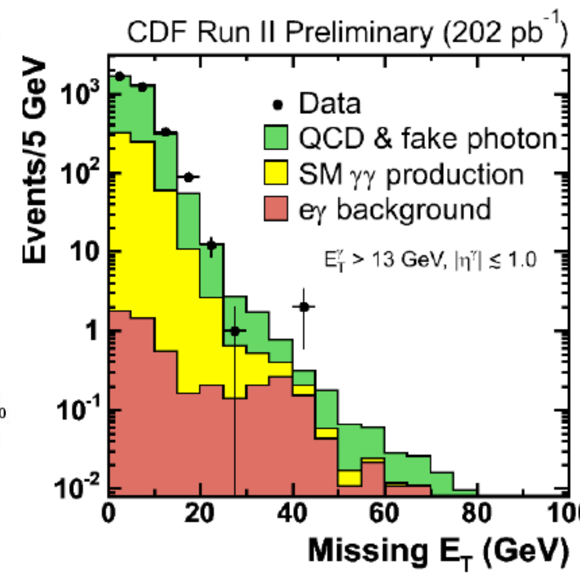


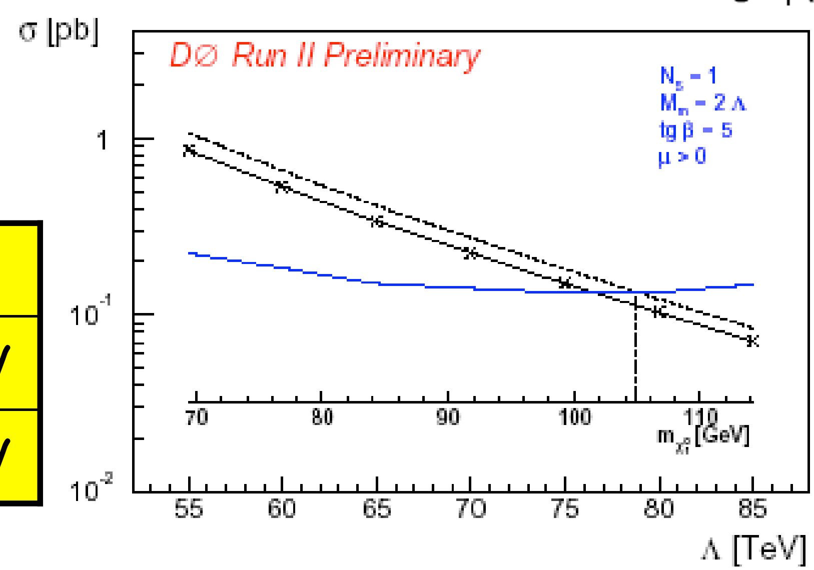


GMSB: $\gamma\gamma+\not{E}_T$

- Assume χ^0_1 is NLSP:
  - Decay to $\tilde{G}+\gamma$
  - $\tilde{G}$ light M~O(1 keV)
  - Inspired by CDF $ee\gamma\gamma+\not{E}_T$ event: now ruled out by LEP
- D0 (CDF) Inclusive search:
  - 2 photons: E_T > 20 (13) GeV
  - $\not{E}_T$ > 40 (45) GeV



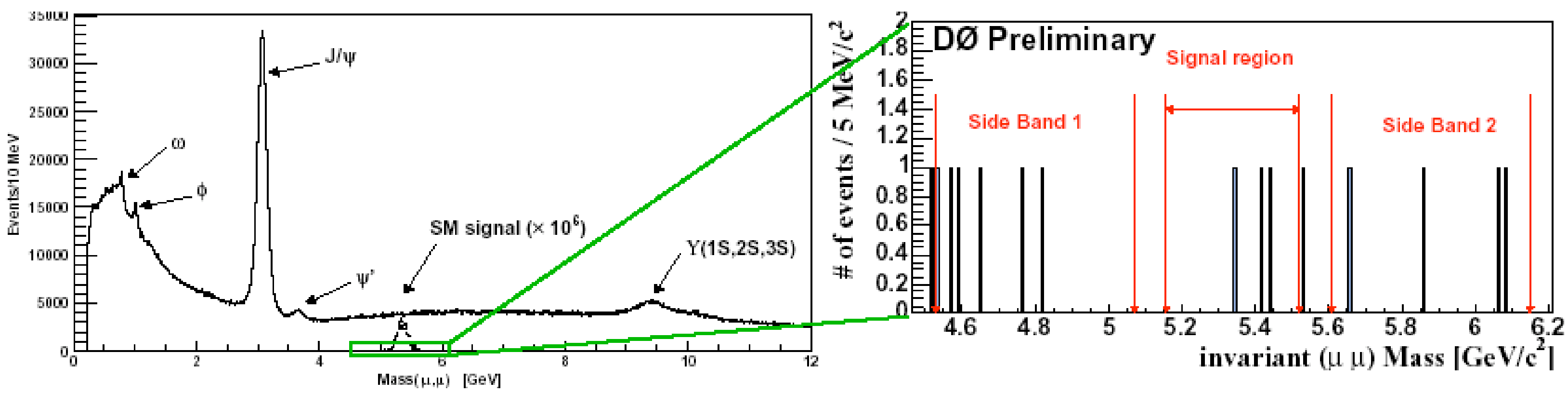




	Exp.	Obs.	$M(\chi^+_1)$
D0	2.5±0.5	1	>192 GeV
CDF	0.3±0.1	0	>168 GeV

Indirect Search: $B_s \to \mu\mu$

- BR($B_s \to \mu\mu$):
  - SM: 3.5×10^{-9} (G. Buchalla, A. Buras Nucl. Phys. B398, 285)
  - SUSY: $\propto \tan^6\beta$ (G. Kane et al., hep-ph/0310042)
- Selection:
  - 2 muons, displaced vertex
  - Topological cuts



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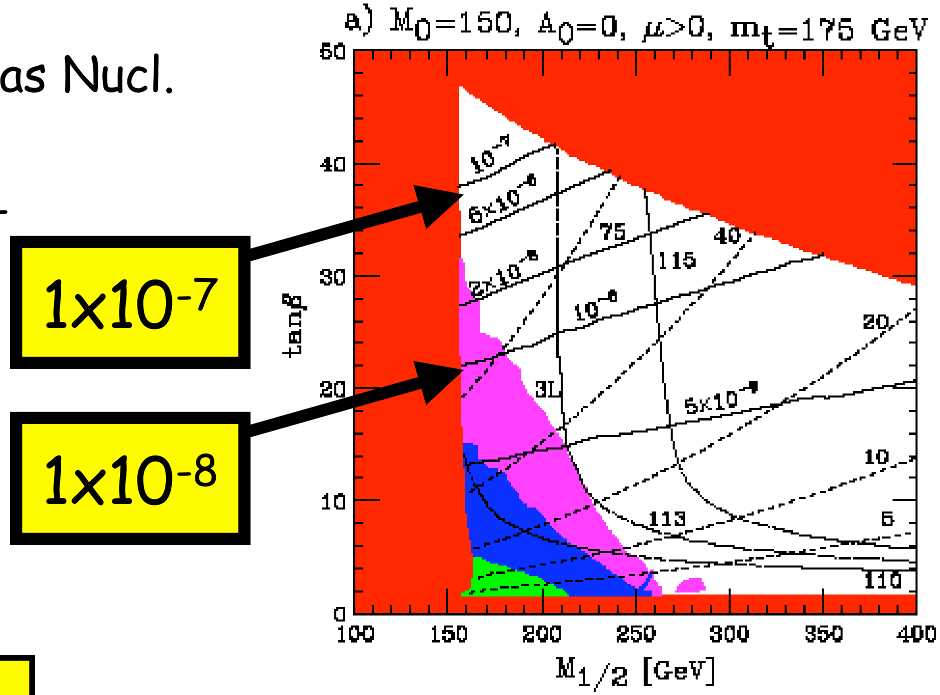
- Selection:
  - 2 muons, displaced vertex
  - Topological cuts

(Dedes et al., hep-ph/0207026)



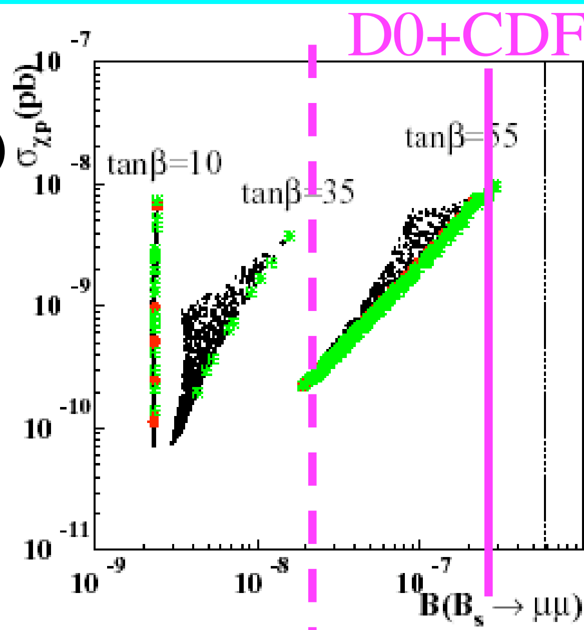
	D0	CDF
expected	3.7±1.1	1.1±0.3
observed	4	1
BR@90% C.L.	$<5.0\times10^{-7}$	$<7.5\times10^{-7}$

- CDF&D0 (M. Herndon):
  - $BR(B_s \to \mu\mu) < 2.7\times10^{-7}$ @90%C.L.

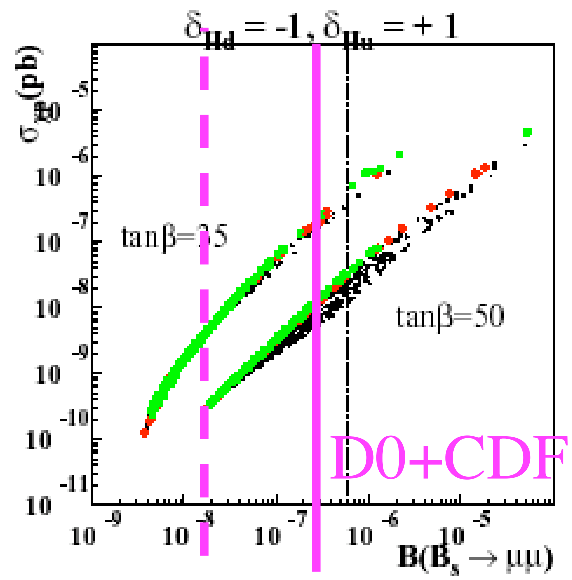
Bs->μμ vs DM cross section

Less than, within, Greater than 2 σ of WMAP,

(Baek et al.: hep-ph0406033)



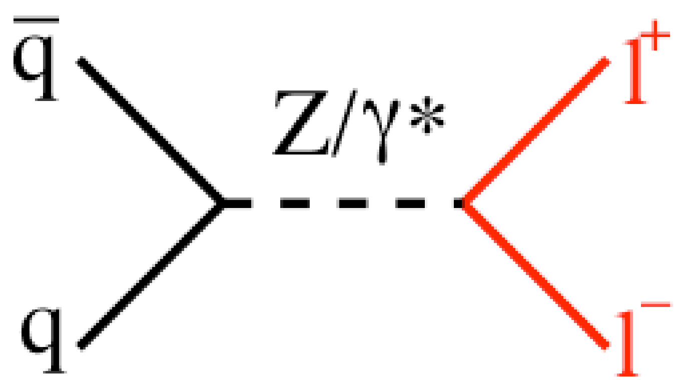
- Probe SUSY parameter space consistent with WMAP data:
  - mSUGRA: just touching…
  - SO10-models (Dermisek et al. hep/ph-0304101) => already constraining
- Bs->μμ complementary to direct DM detection experiments

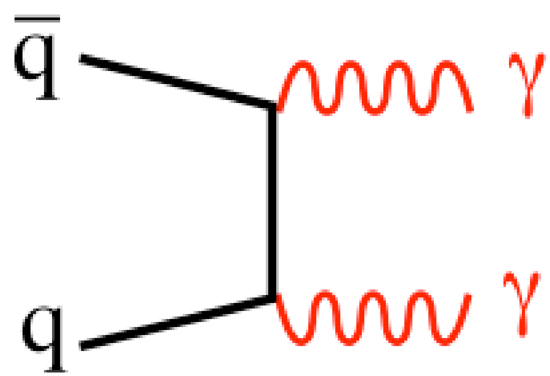


M_0=300 GeV, A_0=0

High Mass Dileptons and Diphotons

Standard Model high mass production:



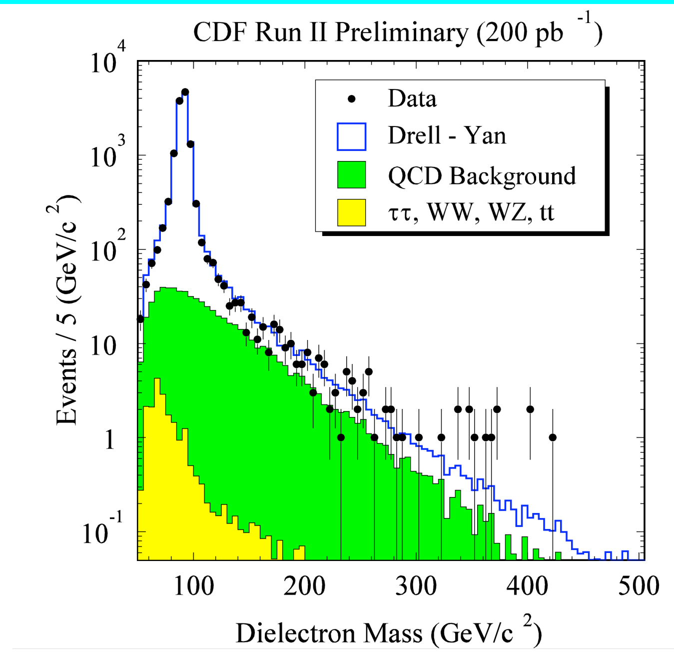


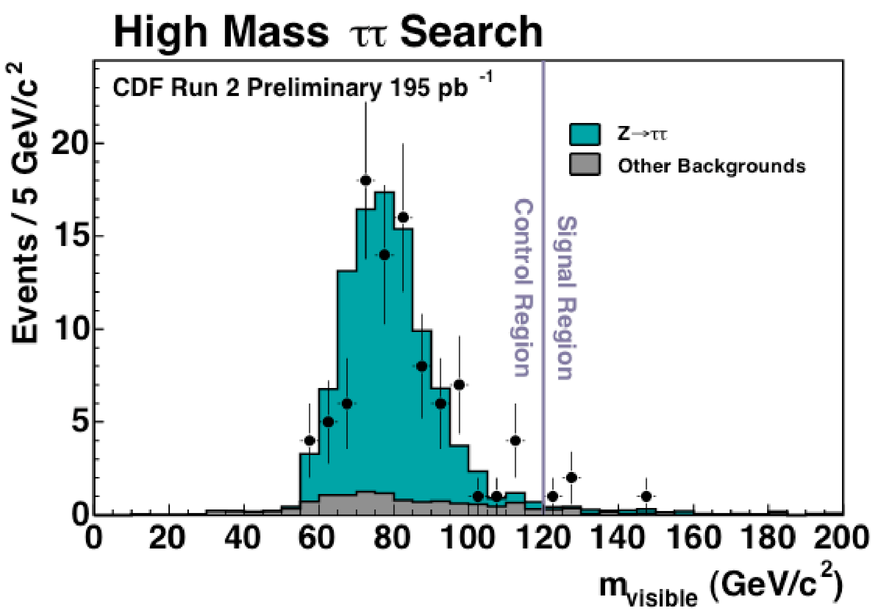
New physics at high mass:

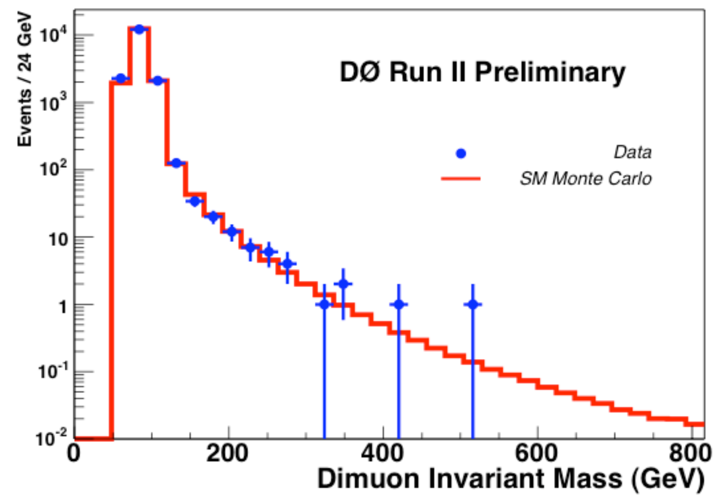
- Resonance signature:
  - Spin-1: Z'
  - Spin-2: Randall-Sundrum (RS) Graviton
  - Spin-0: Higgs
- Tail enhancement:
  - Large Extra Dimensions: Arkani-Hamed, Dimopoulos, Dvali (ADD)
  - Contact interaction

Neutral Spin-1 Bosons: Z′

- 2 high-Pt electrons, muons, taus
- Data agree with BG (Drell-Yan)
- Interpret in Z′ models:
  - E6-models: ψ, η, χ, I
  - SM-like couplings (toy model)



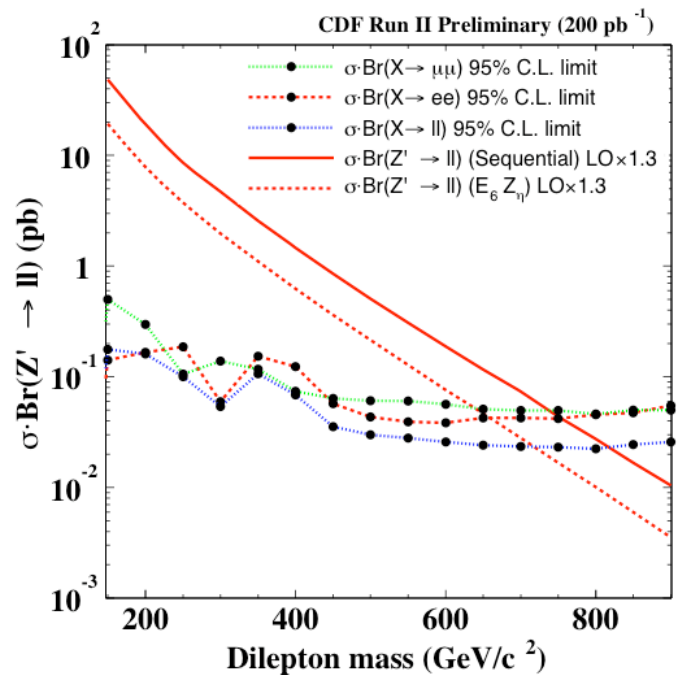


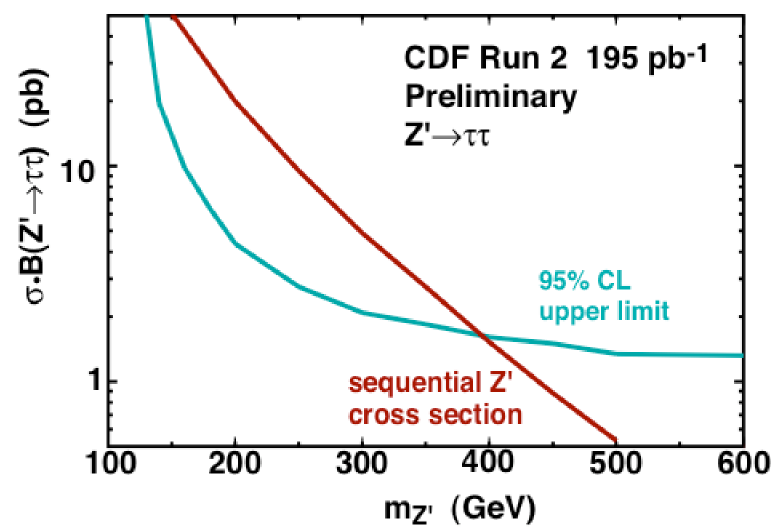


Neutral Spin-1 Bosons: Z'

- 95% C.L. Limits for SM-like Z' (in GeV):

	ee	μμ	ττ
CDF	>750	>735	>395
D0	>780	>680	-

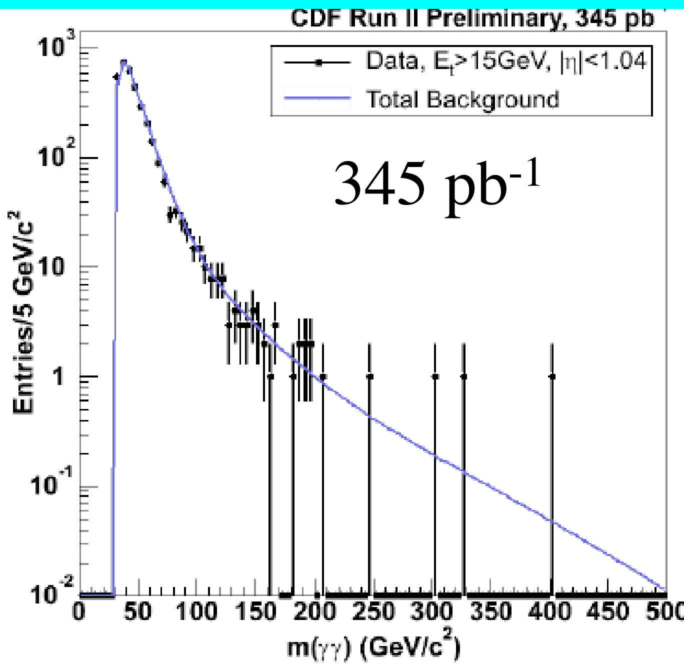


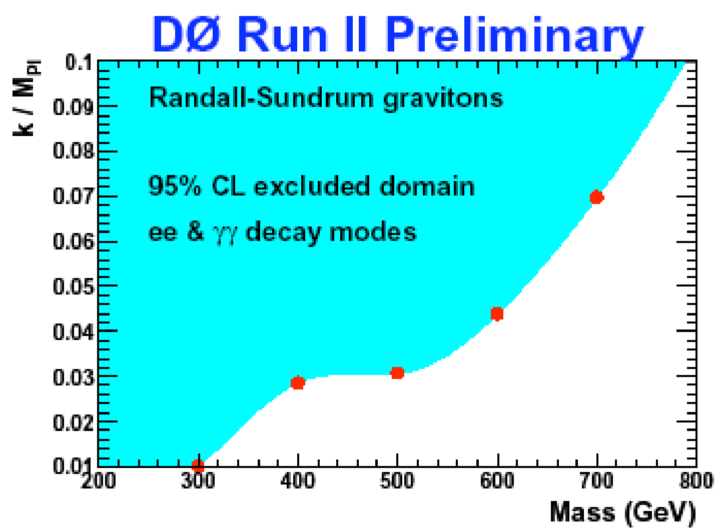


Combined CDF limit:
M(Z')>815 GeV/c^2

Randall-Sundrum Graviton

- Analysis:
  - D0: combined ee and $\gamma\gamma$
  - CDF: separate ee, $\mu\mu$ and $\gamma\gamma$
- Data consistent with background
- Relevant parameters:
  - Coupling: k/M_{Pl}
  - Mass of 1st KK-mode
- World's best limit from D0:
  - M>785 GeV for k/M_{Pl}=0.1

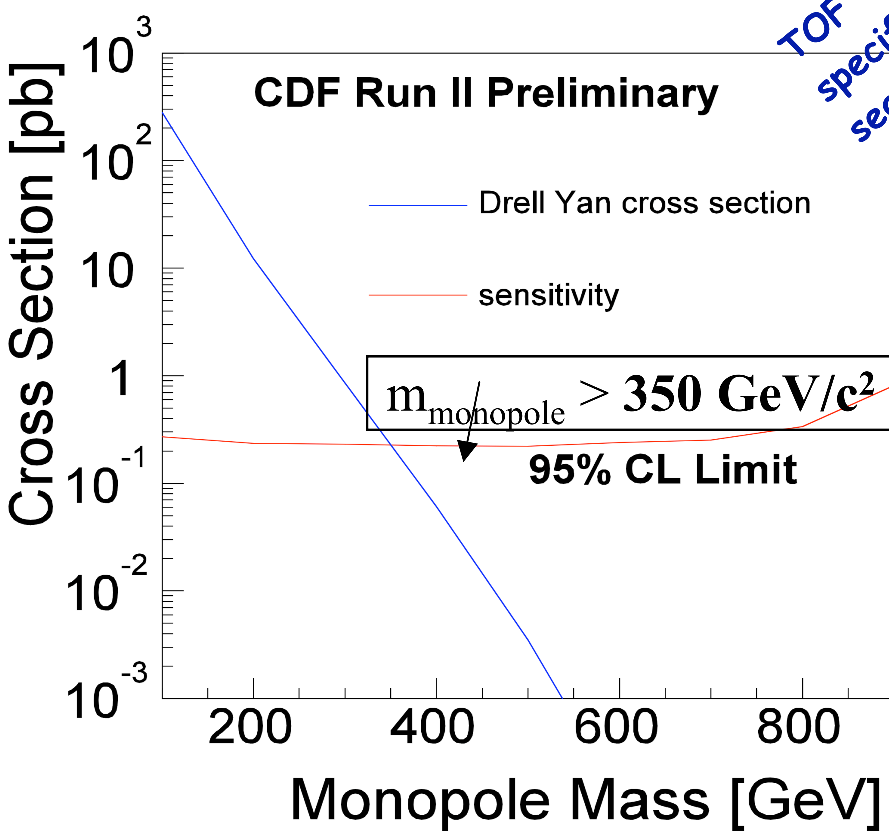


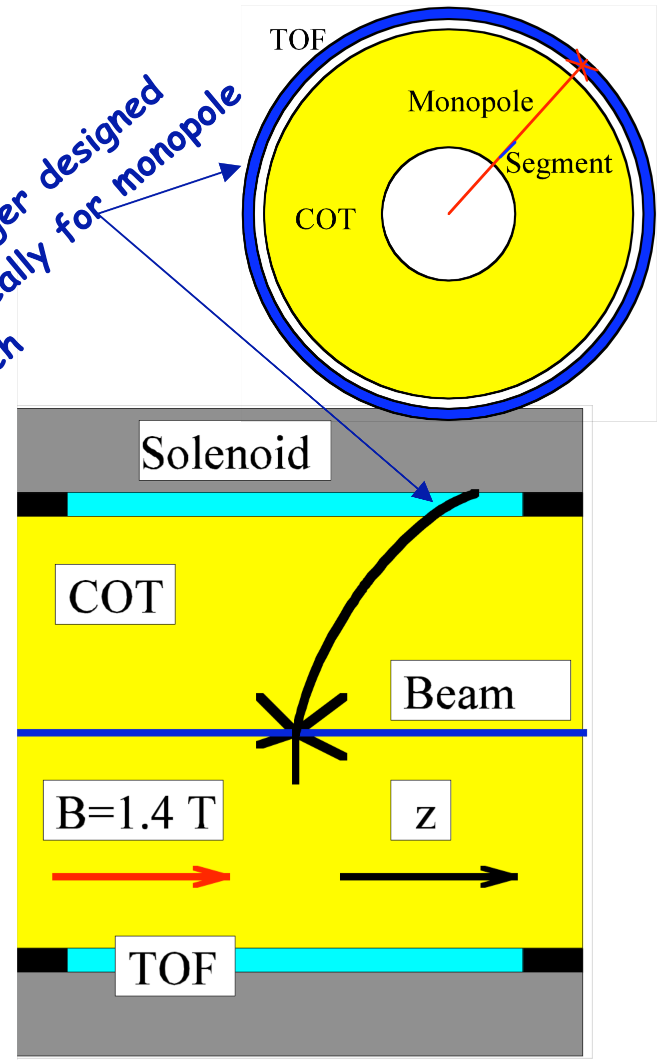


Dirac Magnetic Monopole

- Bends in the ***wrong*** plane (→ high pt)
- Large ionization in scint **(>500 Mips!)**
- Large dE/dx in drift chamber

TOF trigger designed specifically for monopole search



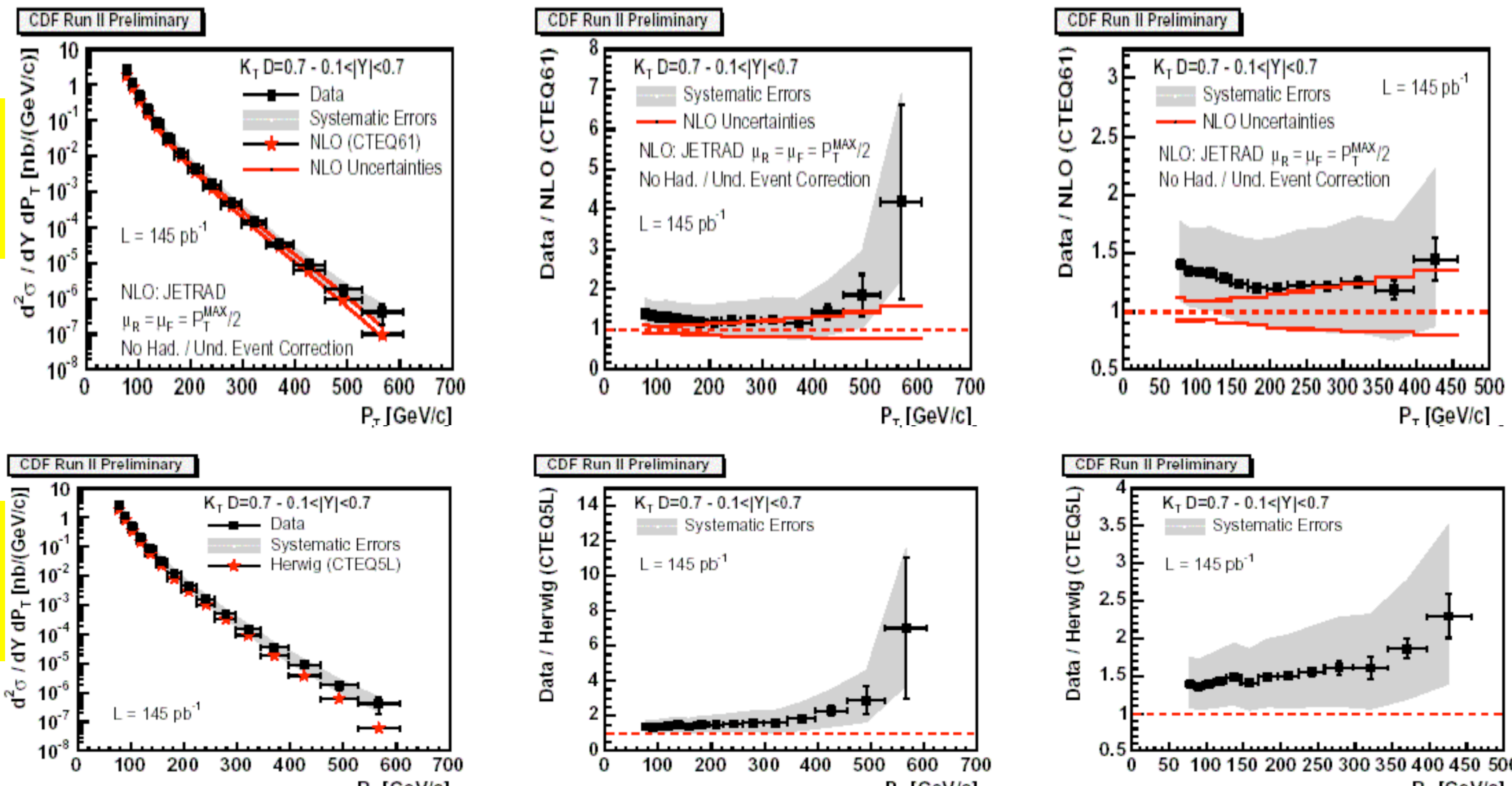


High E_t Jets: k_t-Algorithm

- High Et excess/new physics, constrain high-x gluon
- This time with k_t-algorithm!

Data vs NLO

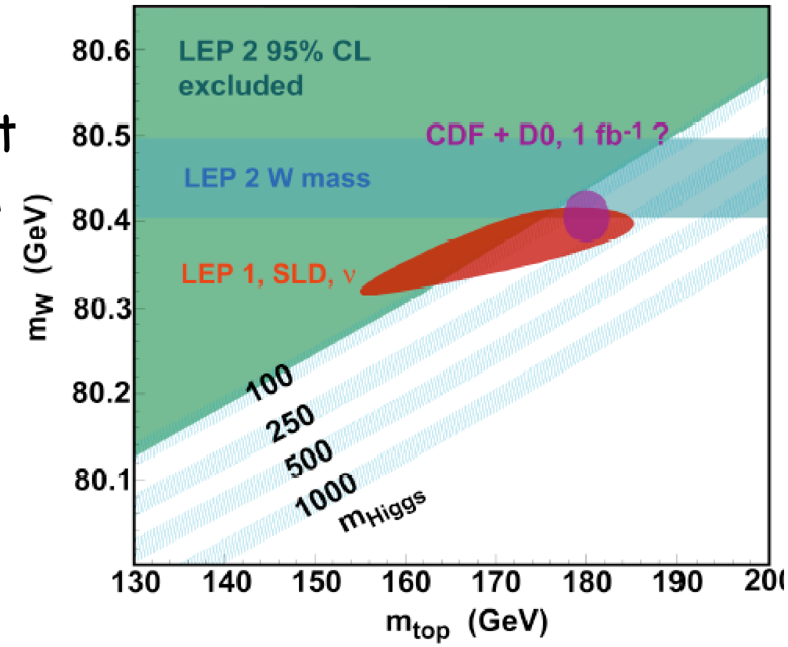
Data vs Herwig



Will improve syst. Error on jets before publishing

Summary and Outlook

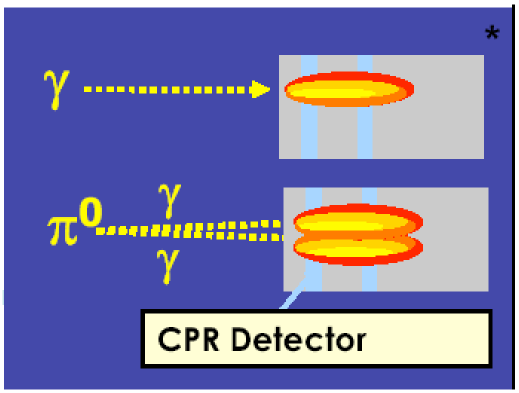
- Run II is running at full speed:
  - Machine and experiments running great
  - Often already world's best constraints
  - Have got 2x more data on tape!
  - Anticipate 1.5-2 fb^{-1} by 2007 and
    4.4-8.6 fb^{-1} by 2009
- Results:
  - Cross sections all agree well with predictions
  - Improved top and W mass measurements very soon
  - Many searches ongoing: higgs, SUSY, LED,…
- It's a lot of fun these days!



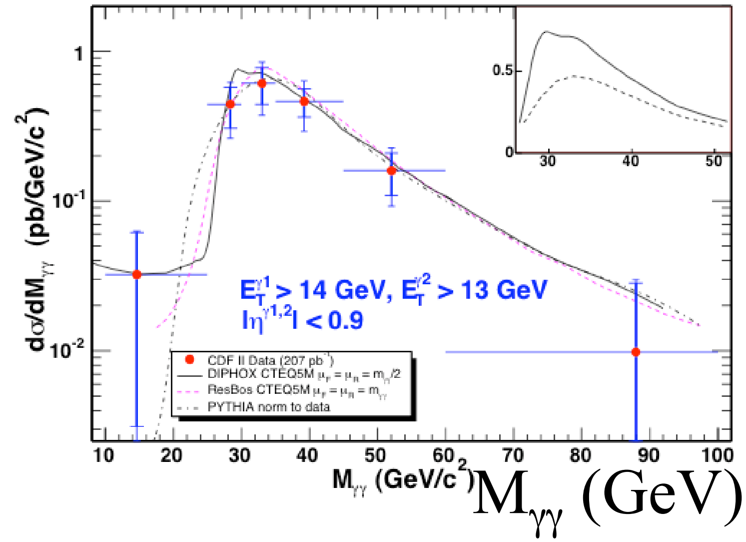
Backup Slides

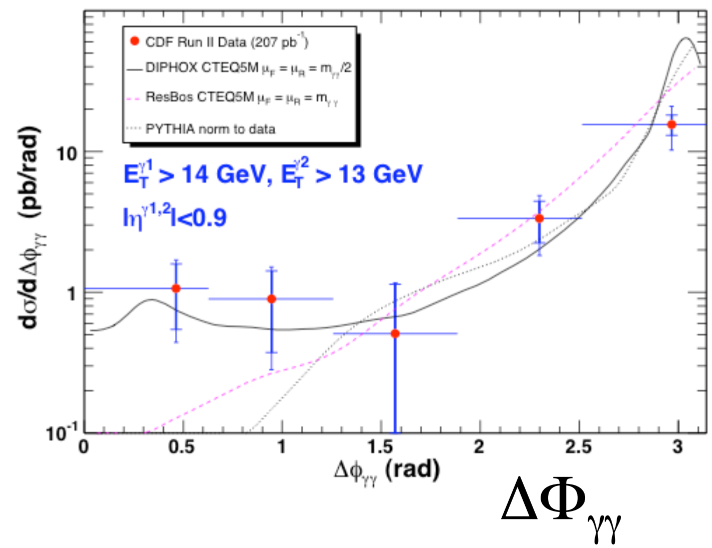
Di-Photon Cross Section

- Select 2 photons with E_T>13 (14) GeV
- Statistical subtraction of BG (mostly $\pi^0 \rightarrow \gamma\gamma$)

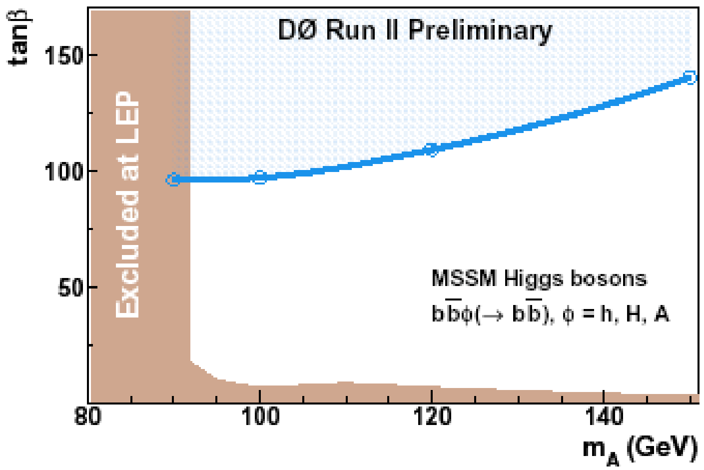


- Data agree well with NLO
- PYTHIA describes shape (normalisation off by factor 2)

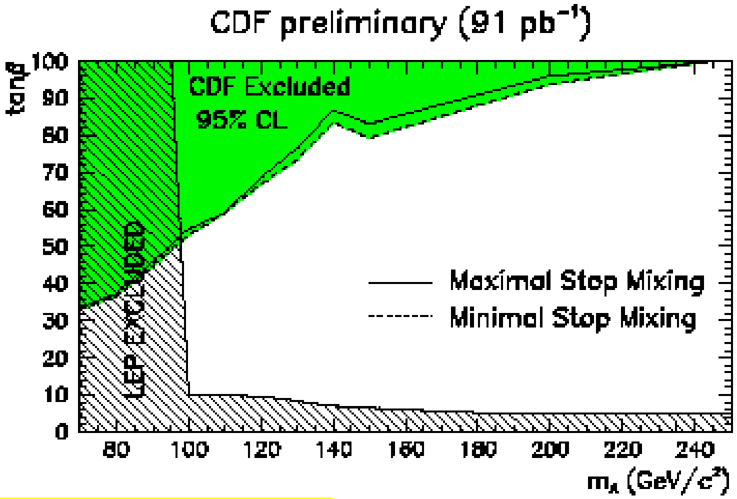




$p\bar{p}$-> bbA ->bbbb



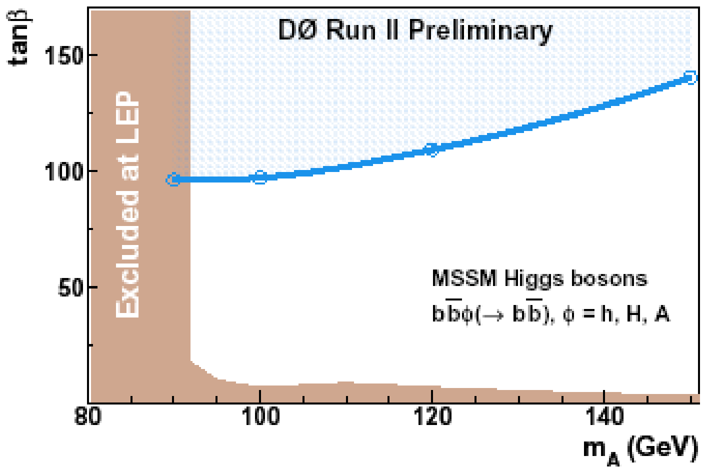
DZero Run II Limit; March 2004
Using 130 pb^{-1}



CDF Run I Limit; October 2000
Using 91 pb^{-1}

Why D0 so much worse with more data???

$p\bar{p}$-> bbA ->bbbb



DZero Run II Limit; March 2004

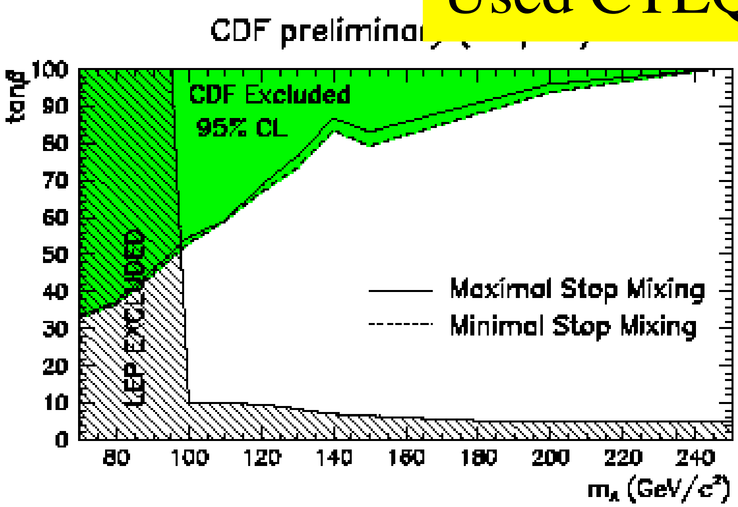
Using 130 pb^{-1}

Used CTEQ5L

CDF Run I Limit; October 2000

Using 91 pb^{-1}

Used CTEQ3L



CTEQ3L 3 times larger acceptance x cross section!

W/Z cross sections: D0 versus CDF

- D0 vs CDF result:
  - Incompatible in Z->μμ channel
  - Otherwise in agreement but higher
  - Luminosity error ≈50% correlated

	CDF (pb)	D0 (pb)	NNLO (pb)
Z->ee	255.8±3.9±5.5±15.4	264.9±3.9±9.9±17.2	251.3±5.0
Z->μμ	248.0±5.9±7.6±14.9	329.2±3.4±7.8±21.4	251.3 ±5.0
W->eν	2780±14±60±167	2865±8±63±186	2687 ±54
W->μν	2768±16±64±166	-	2687 ±54

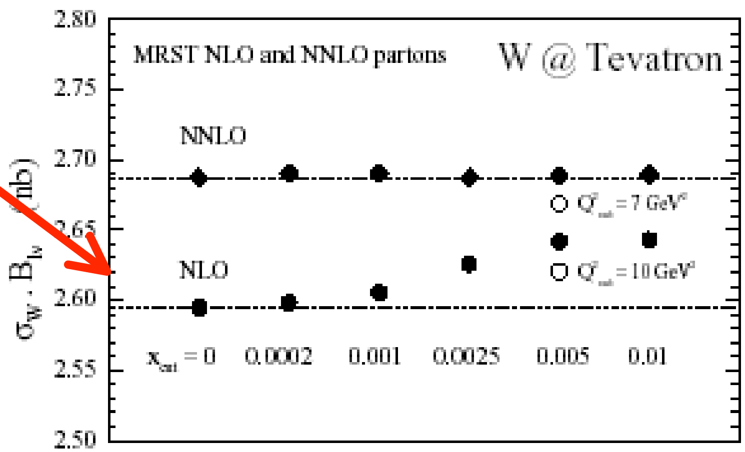
Need better understanding of origin of difference

W and Z cross sections: Luminosity Monitor for LHC/Tevatron?

- CDF 2 measurements: 2% precision

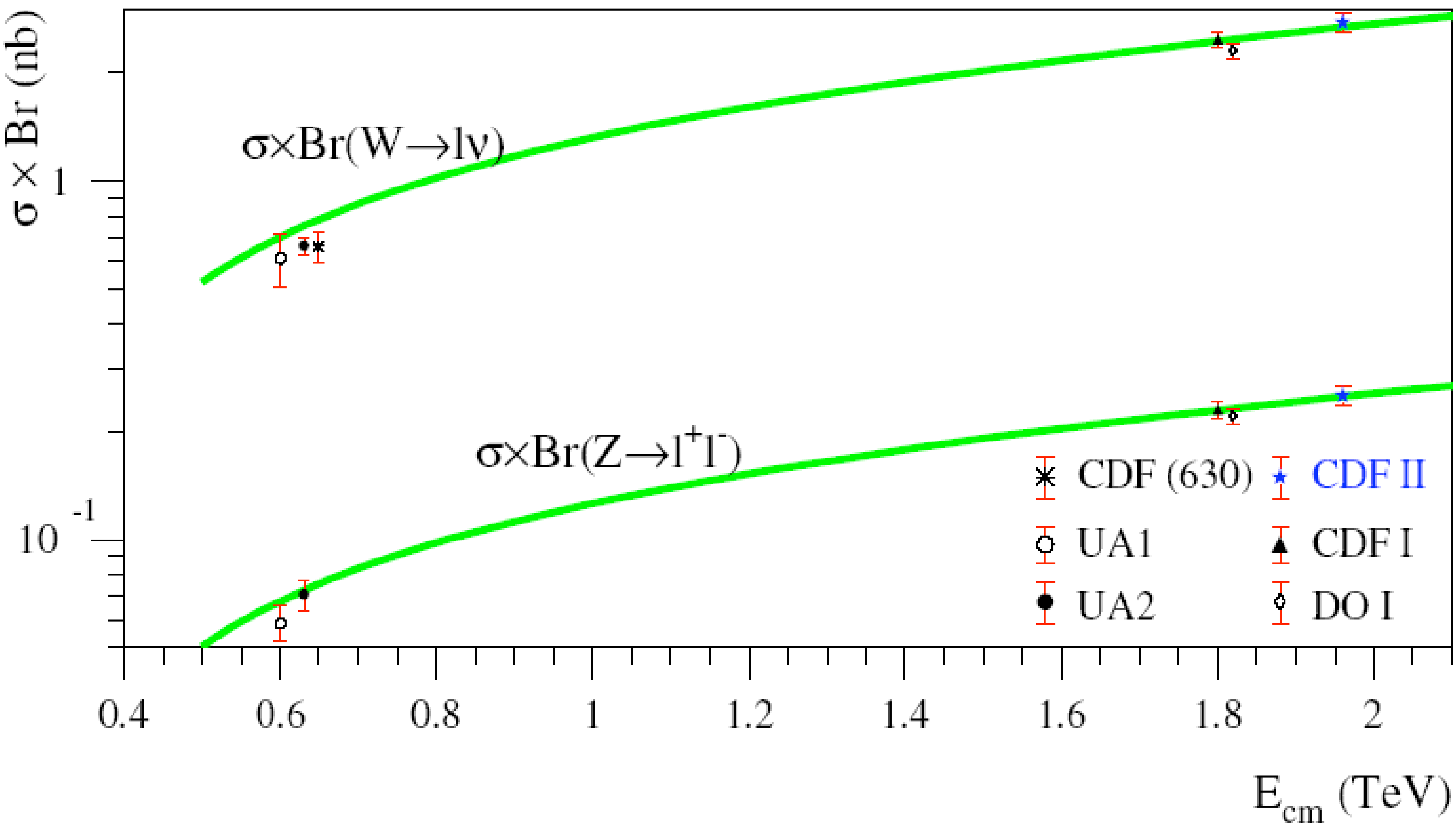
	CDF (pb)	NNLO(pb)
Z	254.3±3.3(st.)±4.3(sys.)±15.3(lum.)	251.3±5.0
W	2775±10(st.)± 53(sys.)± 167(lum.)	2687±54

- NNLO uncertainty also better than 2% (MRST+ L. Dixon)
- NLO not good enough: 4% lower
- Impressive agreement between data and theory: can we use this to measure lumi now to 3%?
- Dominant exp. error due to W/Z rapidity distribution: PDF's…



hep-ph/0308087

W and Z Cross Sections: Summary

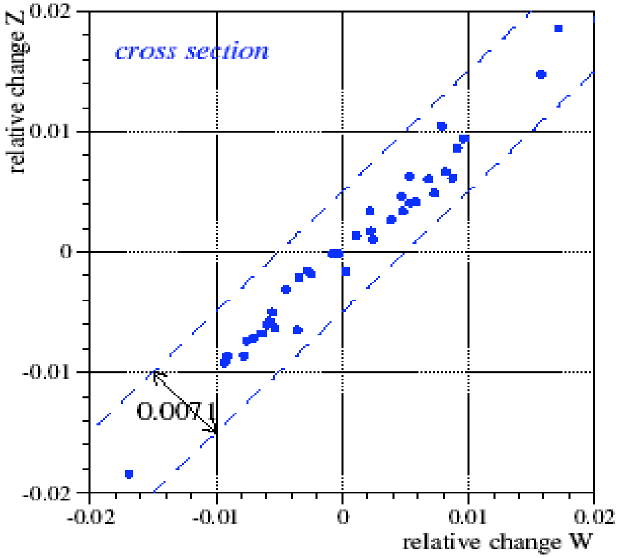


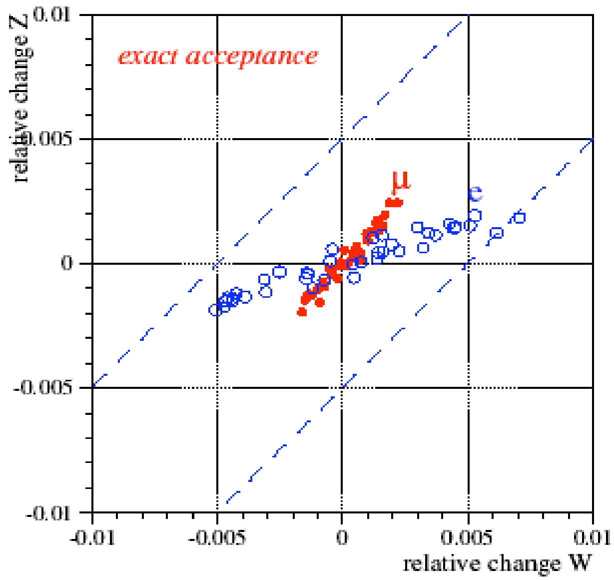
PDF errors in W/Z Production

- Cross section uncertainty factor 5 larger than acceptance errors
- But acceptance uncertainty largest experimental error
- W and Z highly correlated:
  - Achieving better precision (1%) on ratio σ(W)/σ(Z):

$$R = \frac{\sigma(p\bar{p} \to W \to l\,\nu)}{\sigma(p\bar{p} \to Z \to ll\ )} = 10.93 \pm 0.15(stat) \pm 0.13(sys)$$

- electron channel better than muon channel:
  - Larger acceptance due to usage of forward calorimeter





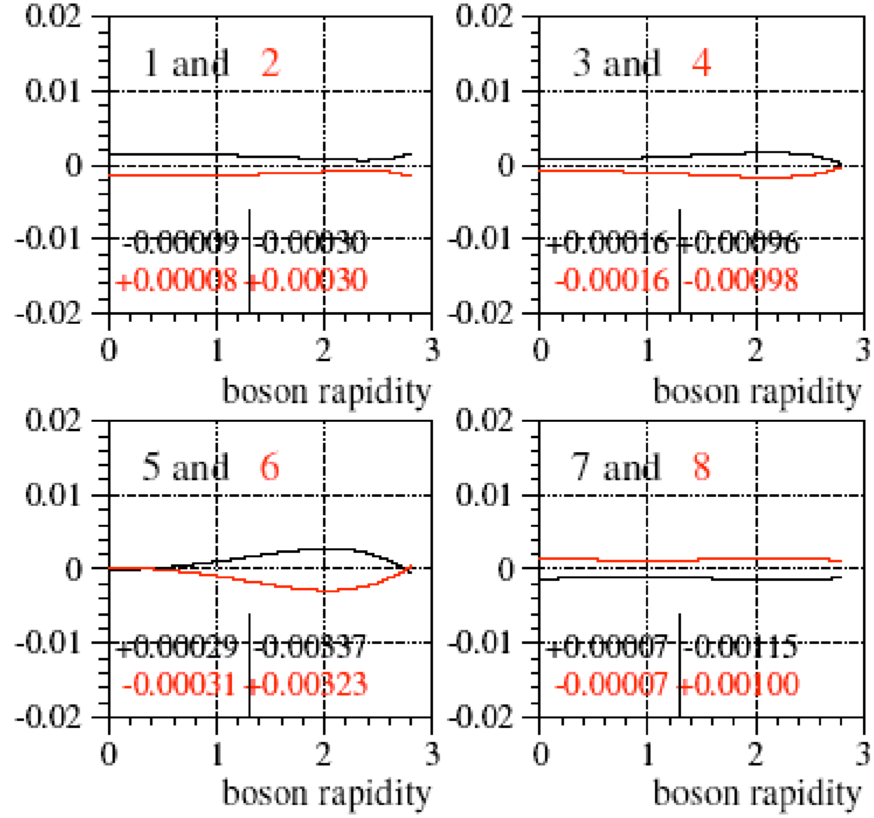
PDF error estimate using CTEQ6

- Use analytical cross section expression (LO) to calculate dσ/dy:

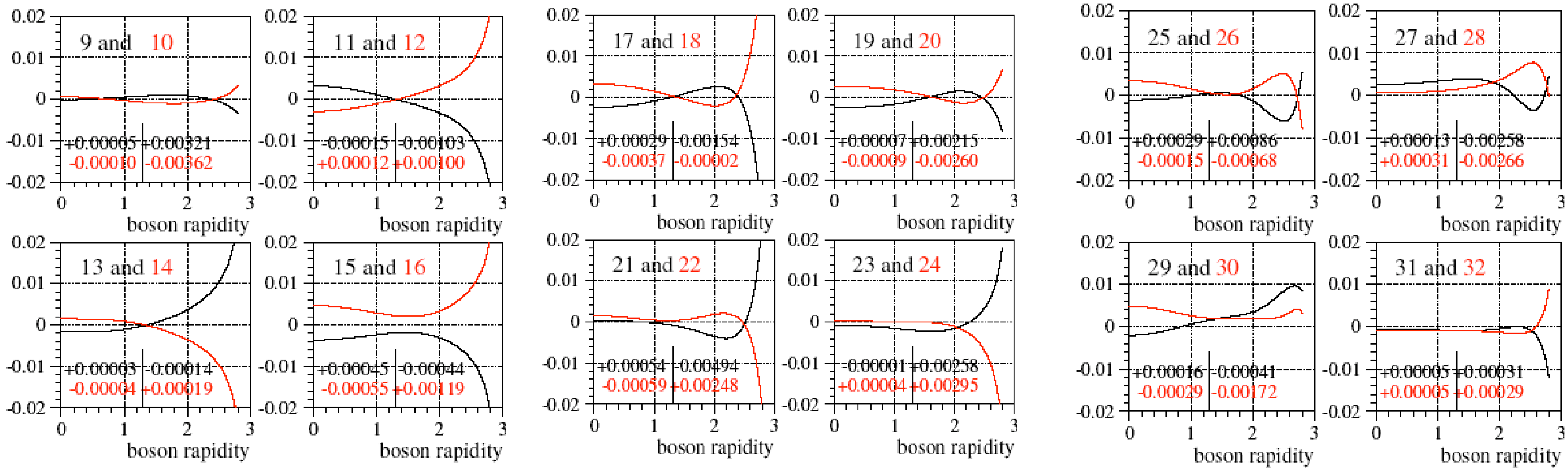
$$\frac{d\sigma_W}{dy} = K \frac{2\pi G_F}{3\sqrt{2}} x_a \, x_b \, u(x_a) \, d(x_b)$$

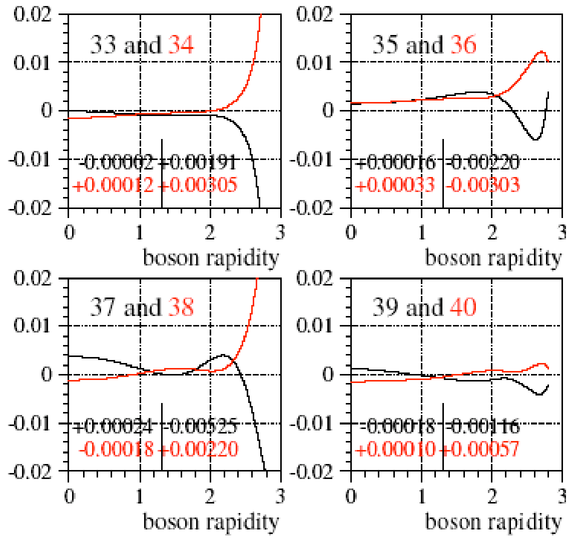
with $x_{a,b} = \frac{M_W}{\sqrt{s}} \exp(\pm y).$

- Integrate for 40 eigenvectors from CTEQ and fold in parametrised experimental acceptance
- Compare also to MRST central fit (MRST error sets give factor 2 smaller uncertainty)
- Plot versus boson rapidity



More CTEQ6 PDF errors

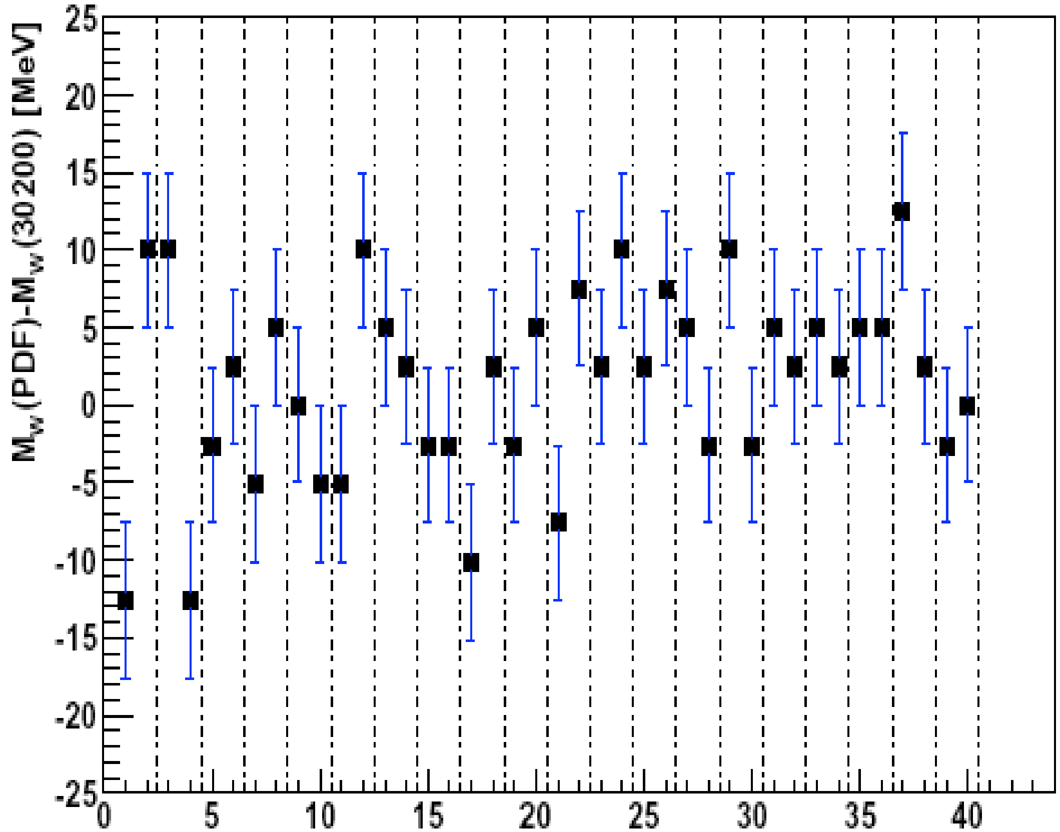




- 11-16 seem most important: can they be constrained better?
- Excellent tool setup to understand real behaviour (not limited by MC statistics)

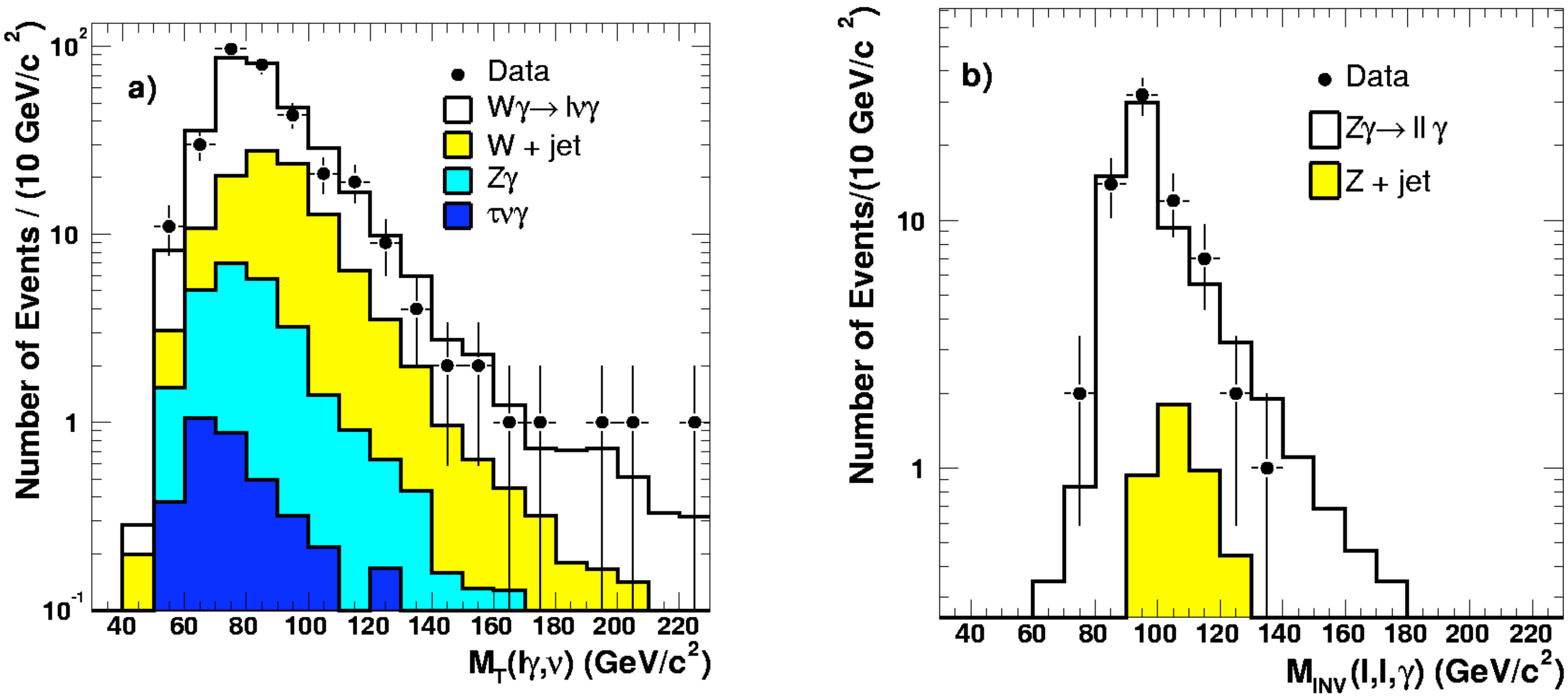
Syst. Error on W mass due to PDF's

40 eigenvectors of CTEQ6 give "90% CL" (J. Huston), i.e. 1.64 σ



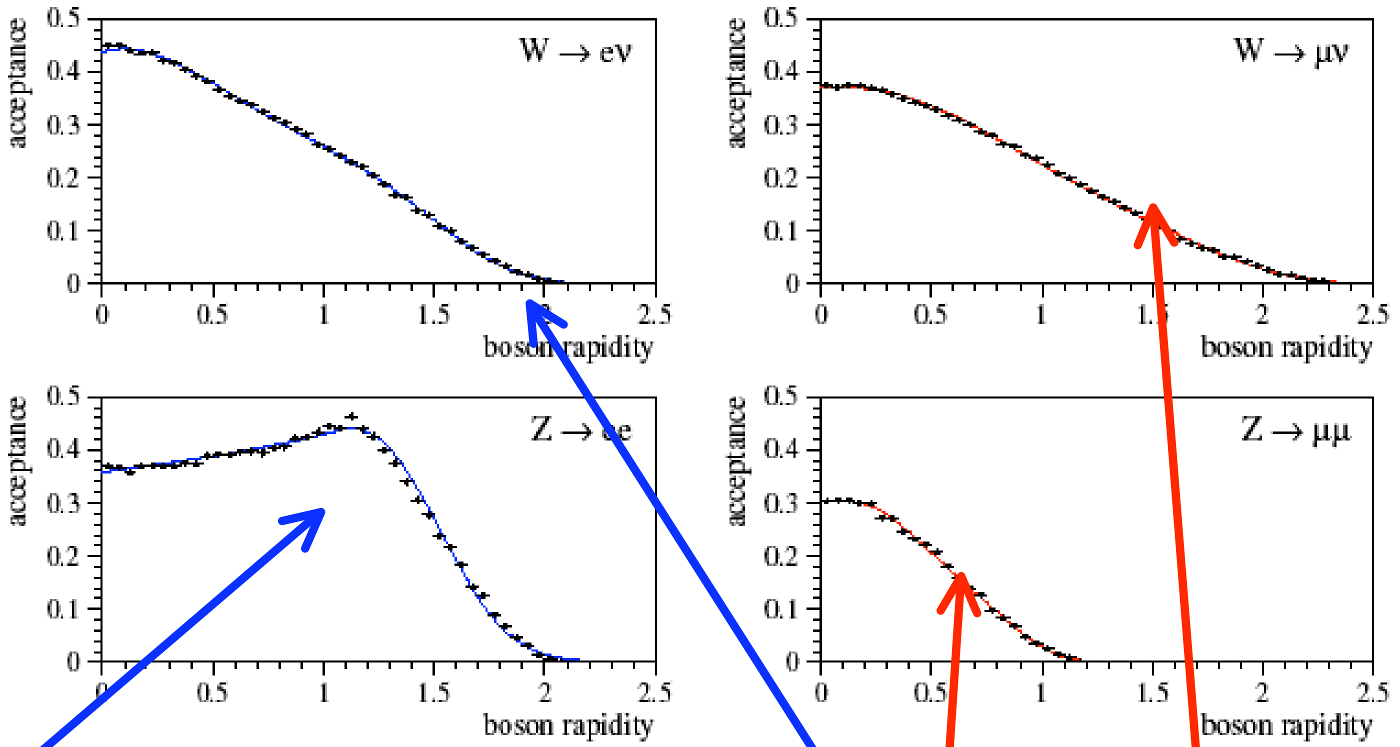
Error calculation: =1/2 $\sqrt{\Sigma(\Delta M_W(+) - \Delta M_W(-))^2}$ /1.64=15 MeV

Mass



- Data agree well with prediction: no sign of any signal of high mass
- $M_T(l\gamma,\nu)$>90 GeV / $M(ll\gamma)$>100 GeV sensitive to TGC's
- Can be used to constrain e.g. W* and Z*

Acceptance versus Rapidity

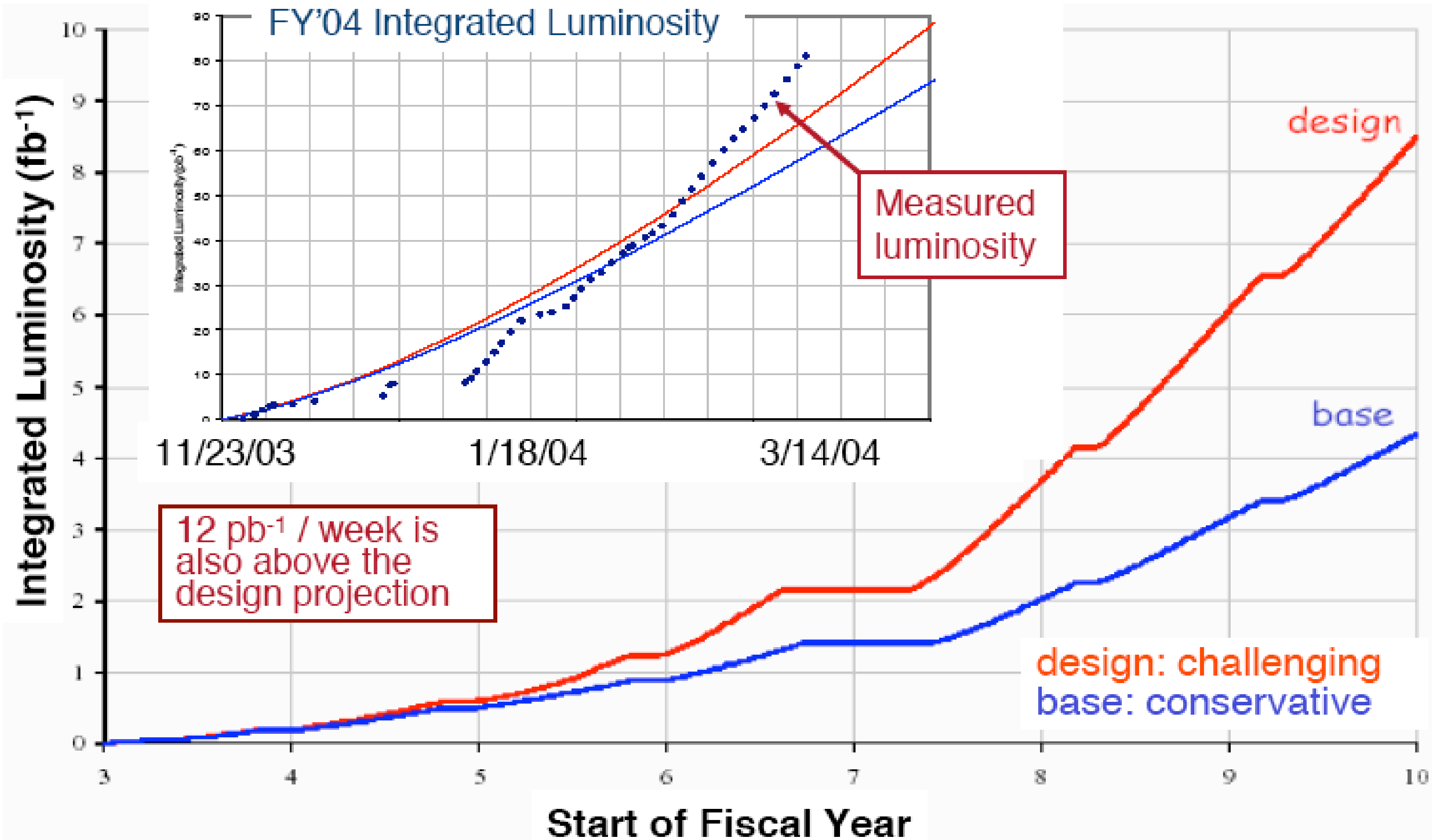


Uses leptons up to η=2.6

Use leptons up to η=1

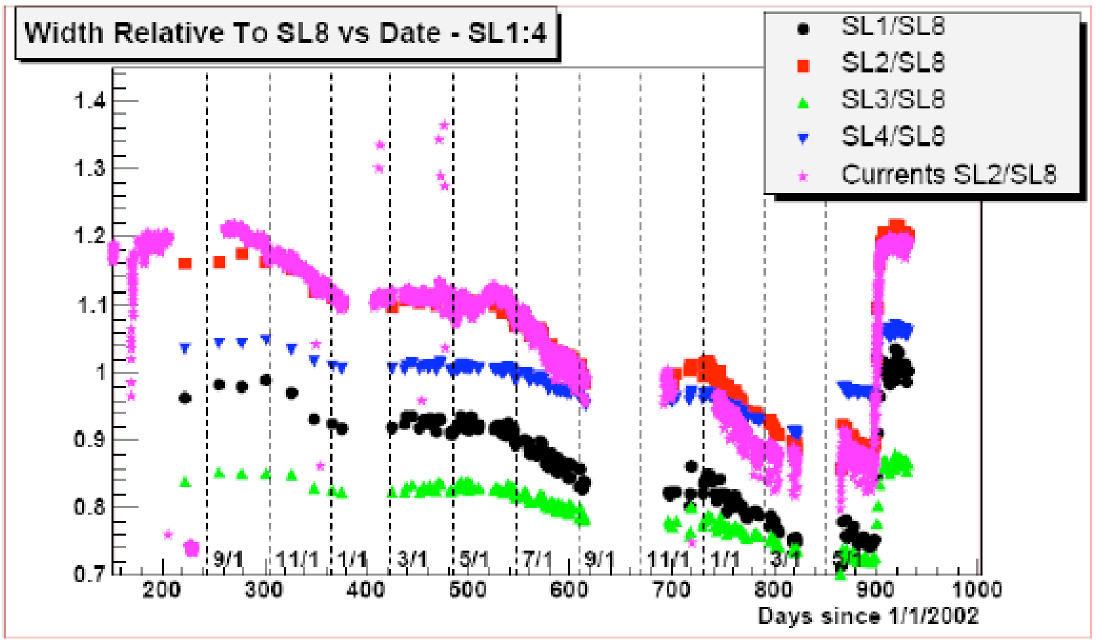
Reducing syst. Error by extending measurements to forward region (or restricting rapidity range?)

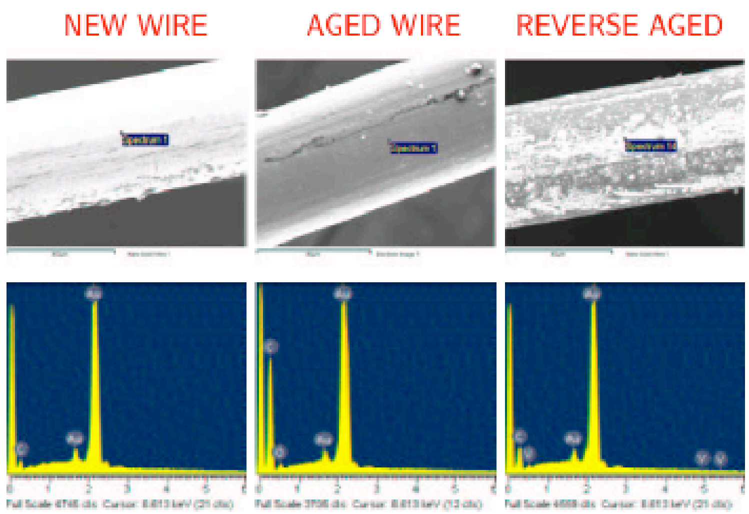
Luminosity Perspectives



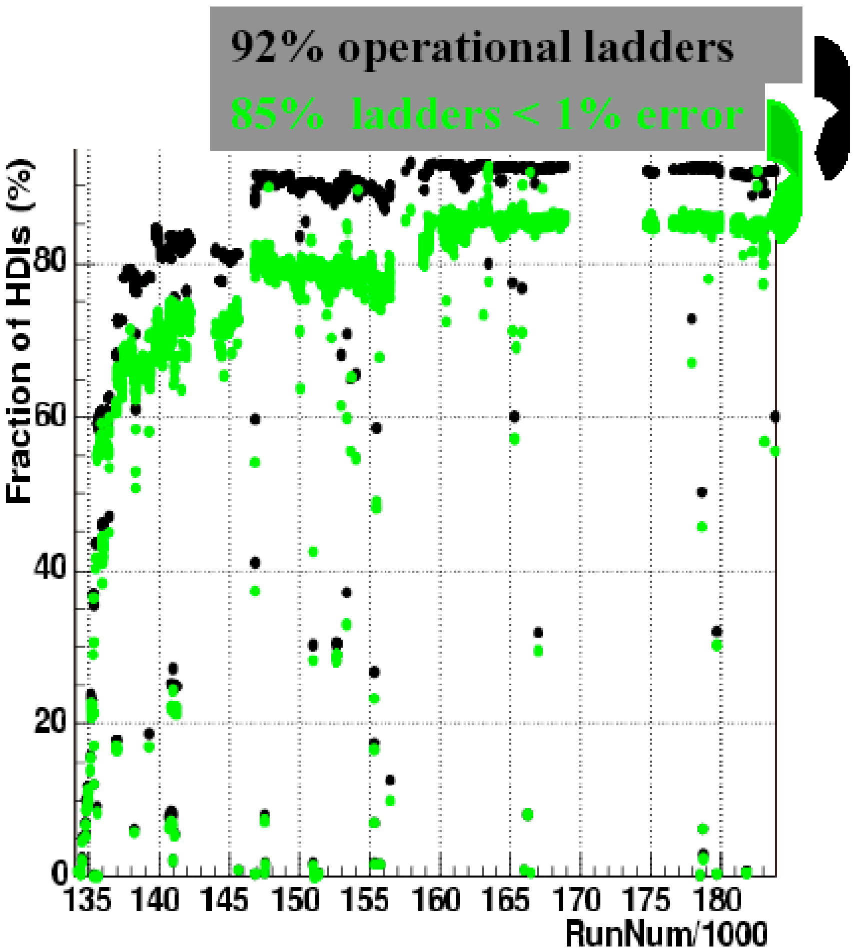
CDF: COT Aging Problem Solved!

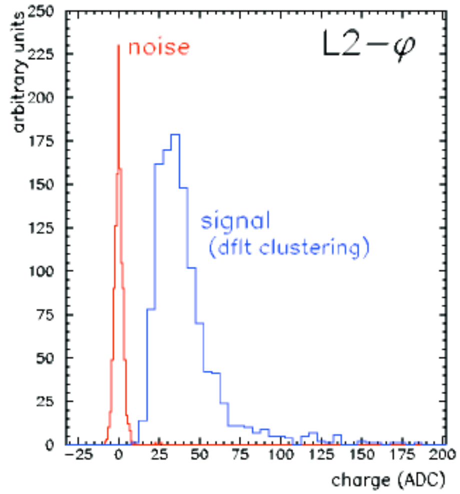
- Gaseous tracking chamber COT: wire aging problem seen in 2003-2004
- hydrocarbon residue detected on sense wires where gain had been falling
- addition of air (probably the oxygen) reverses the aging
- Chamber gains back go pre-aged status
- Voltages reduced on inner superlayers from February to May 2004

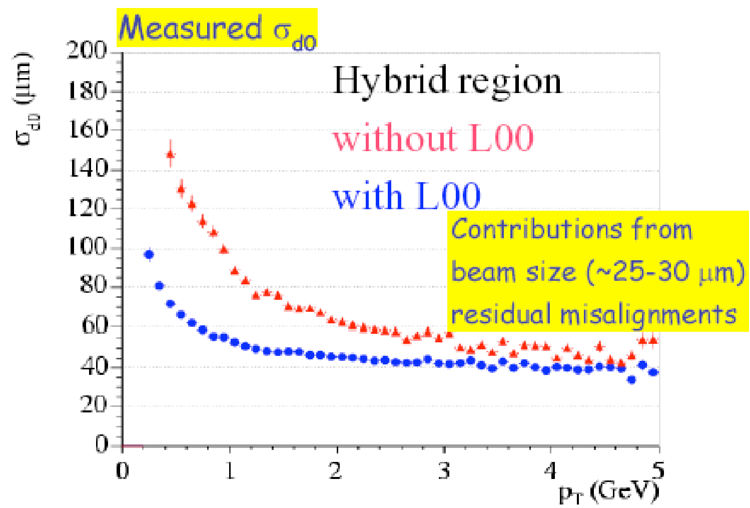




Silicon Performance



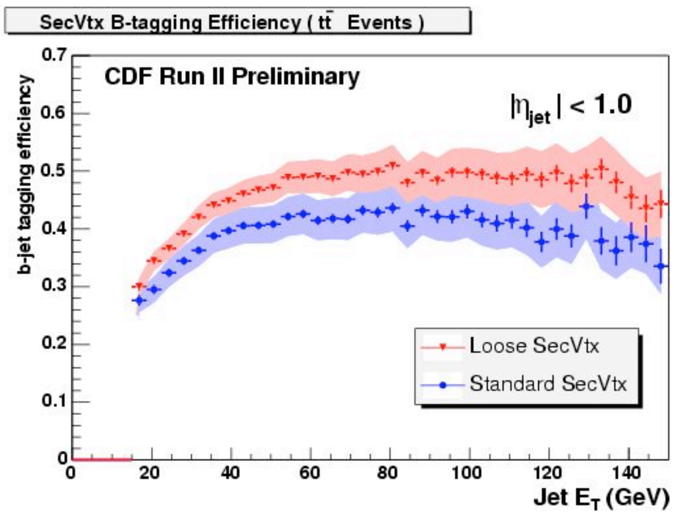


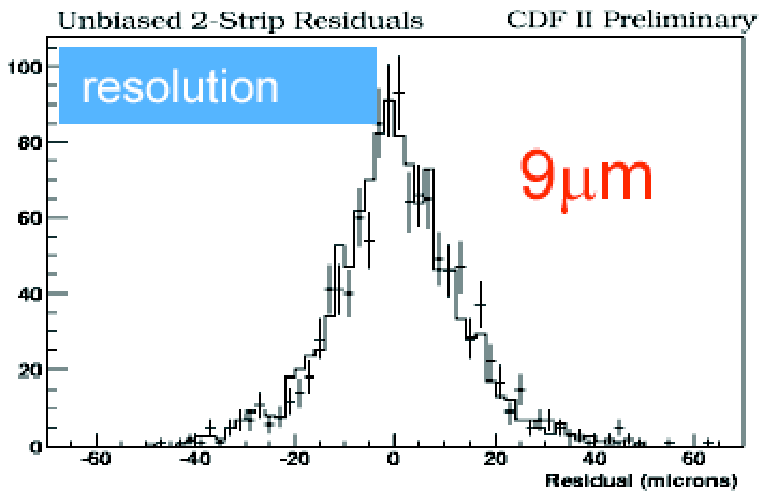


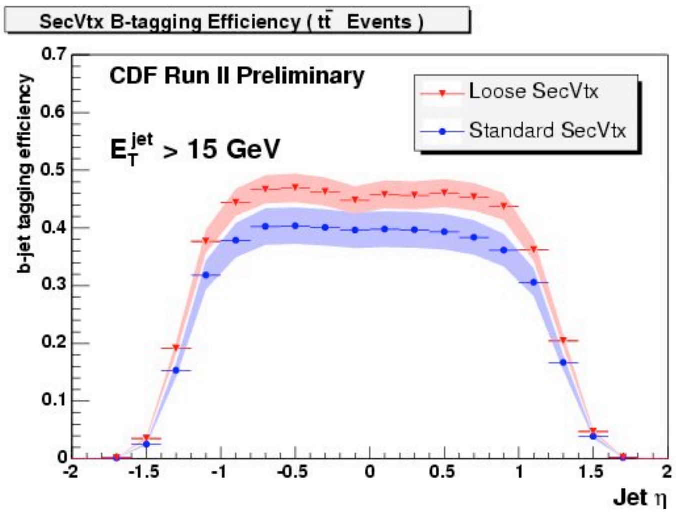
See talk by R. Wallny

CDF: B-tagging and tracking

Requirement	Efficiency	Requirement	Efficiency
$N_{r\phi} \geq 3$	94%	$N_z \geq 3$	80%
$N_{r\phi} \geq 4$	90%	$N_z \geq 4$	61%
$N_{r\phi} = 5$	46%	$N_z = 5$	26%



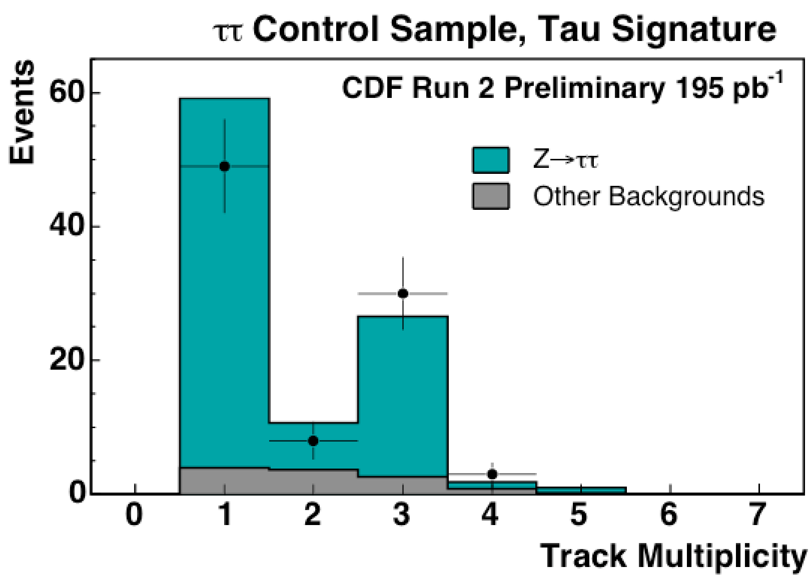


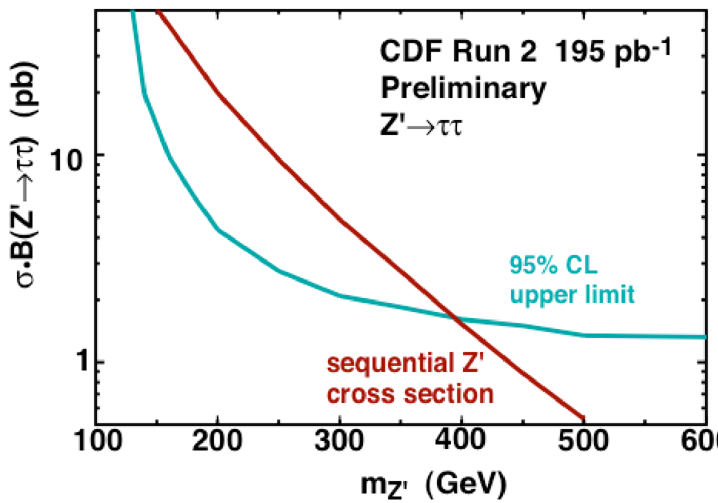


See talk by R. Wallny

Z' -> ττ

- τ's challenging at hadron colliders:
- τ signals established by CDF & D0: W->τν, Z->ττ
  - 1- and 3-prong seen
- Result for m_{vis}>120 GeV:
  - Observe: 4 events
  - Expect: 2.8±0.5
- M(Z')>395 GeV
- Ruled out by ee and μμ channel for SM Z' => explore other models with enhanced τ couplings





RPV Neutralino Decay

- Model:
  - R-parity conserving production => two neutralinos
  - R-parity violating decay into leptons
  - One RPV couplings non-0: λ_{122} , λ_{121}
- Final state: 4 leptons + $\not{E}_t$
  - eee, eeμ, $\mu\mu$e, $\mu\mu\mu$
  - 3rd lepton P_t>3 GeV
  - Largest Background: $b\bar{b}$
- Interpret:
  - M_0=250 GeV, tanβ=5

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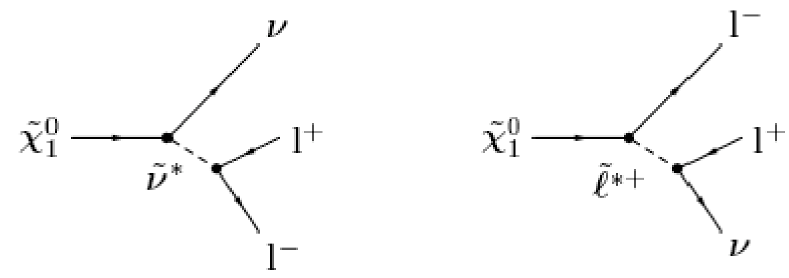
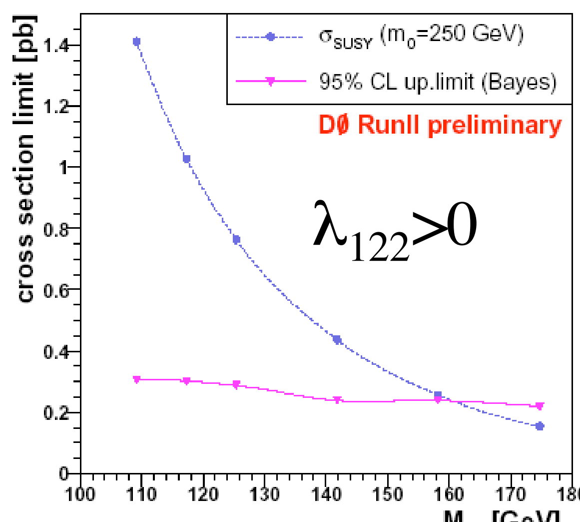
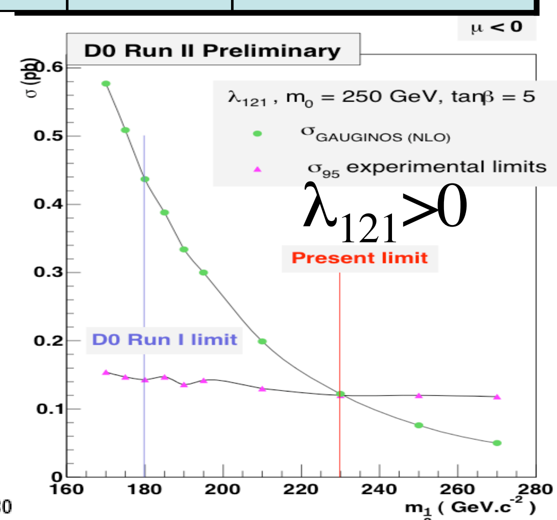


	Obs.	Exp.
eel (l=e,μ)	0	0.5±0.4
$\mu\mu$l (l=e,μ)	2	0.6+1.9-0.6





$\boxed{m(\tilde{\chi}^+_1) > 160 \text{ GeV}}$ $\boxed{m(\tilde{\chi}^+_1) > 183 \text{ GeV}}$